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- MARRIAGE COUNSELING FOR SCIENCE AND GOVERNMENT
- SPANNING JAPAN: THE WORLD'S BIGGEST BRIDGE PROJECT

The New Alchemy

High Pressure Yields a Treasure Trove of Exotic Materials

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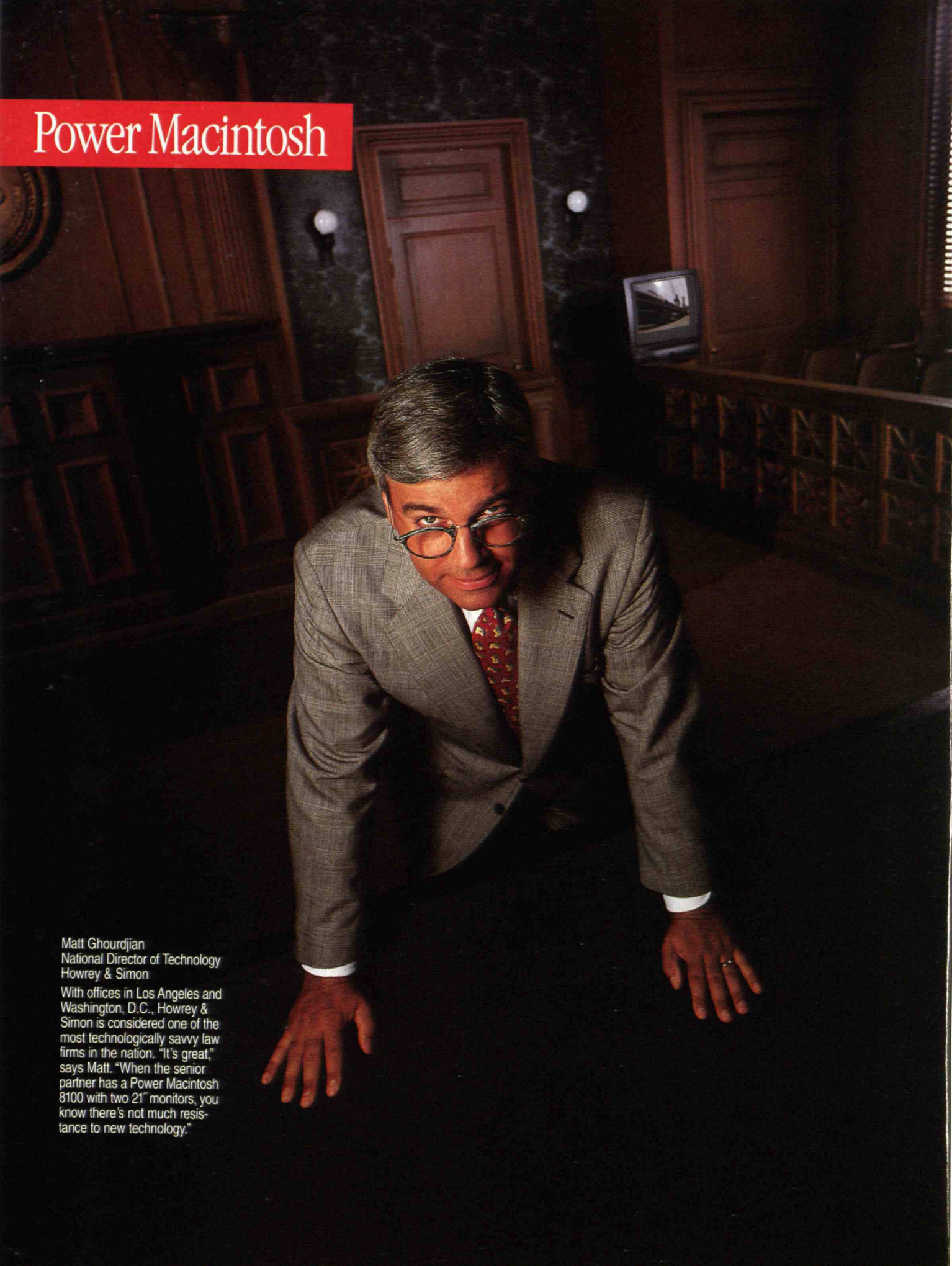

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NOVEMBER/DECEMBER 1994

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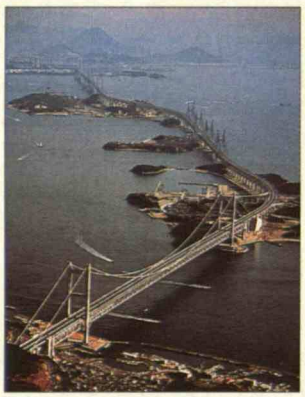

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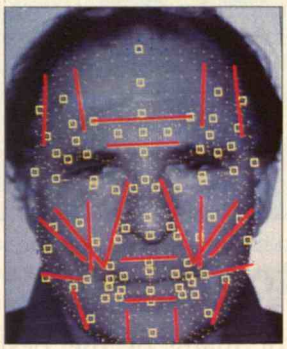

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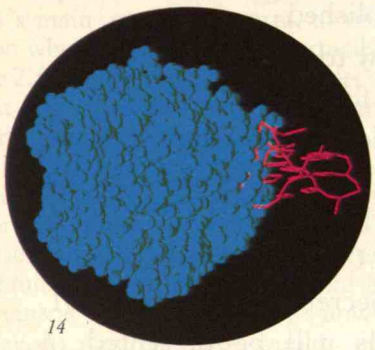

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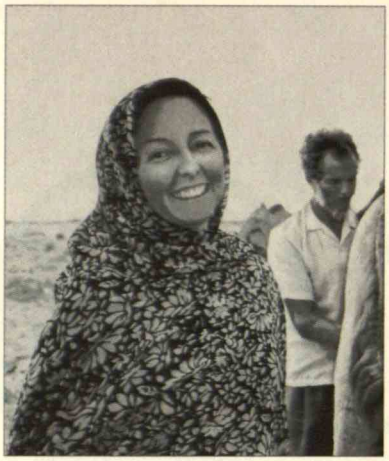
APPLIED SCIENCES AND INVENTION
1993, Nancy Abeiderrahmane (MAURITANIA)
Pasteurizing camel's milk in the desert.



EXPLORATION AND DISCOVERY
1984, Donald Perry (USA)
Invents "spiders web" forest canopy research.

THE ENVIRONMENT
1981, Milan Mirkovic (AUSTRALIA)
Cultivating the jojoba plant in the desert.

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Mr. Ricardo Bofill (Spain): Architect, founder of the Taller de Arquitectura in Barcelona.

Mrs. Laila El-Hamamsy (Egypt): Anthropologist, Professor Emeritus at the American University of Cairo.

Professor Reinhard Furrer (Germany): Physicist and astronaut, Managing Director of the Berlin Space Institute.

Mr. William Graves (United States): Editor of *National Geographic* magazine.

Professor Tommy Koh (Singapore): Law professor and diplomat, Chairman of the National Arts Council and Director of the Institute of Policy Studies.

Professor Luc Montagnier (France): Research virologist, Professor at the Pasteur Institute in Paris, Research Director at the National Scientific Research Centre (CNRS).

Dr. Ivo Pitanguy (Brazil): Plastic surgeon, Director of the Ivo Pitanguy Clinic and Professor at the Carlos Chagas Medical School of Rio de Janeiro's Catholic University.

Ms. Junko Tabei (Japan): Mountaineer, Representative of the Himalayan Adventure Trust.

ROLEX

First Line

Patients and Prudence

A relatively young and seemingly healthy friend of mine—call him Jules—was advised out of the clear blue sky a couple of years ago to undergo open-heart surgery.

Having discovered a heart murmur during a routine annual checkup, his physician quickly called for follow-up tests, first an echocardiogram (an ultrasound procedure) and then an MRI (magnetic resonance imaging) exam, to determine the cause. The tests revealed an aneurysm—a ballooning—of the body's main artery, the aorta, in the region where it left the heart. Normally some 2.5 centimeters in diameter, Jules's aorta had expanded to a maximum breadth almost three times as wide.

The condition could be surgically corrected, cardiologists assured him, though the procedure, featuring a couple of high-tech substitutions—synthetic tubing for the faulty section of the aorta and a mechanical valve for the artery's now-damaged natural one—would be "formidable" and therefore relatively high-risk. But doing nothing, he was told, carried grim prospects. Left untreated, the aorta could eventually rupture, suddenly and catastrophically. And even if by chance it didn't, the chronic valve problem created by the aneurysm would steadily grow worse, causing enlargement of the heart, erosion of its function, and, eventually, heart failure.

My friend's diagnosis resembled the kind of global crises that environmentalists have regularly been warning us about, even though we live in an affluent and seemingly promising time: they depict a bleak future for life on earth unless we change our polluting ways and do it soon, enduring the inevitable short-term upheavals for the long-term good. Jules also had to wrestle with an abstract, easy-to-deny quality to his situation, just as policymakers often must when confronting global-change scenarios.

For one thing, he felt fine. Thus he was tempted to leave well enough alone and not permit the invasion of an otherwise healthy body for some far-off threat. Yet if change is needed, the best time to act might be when the "patient"—whether one individual or the whole planet—is at its youngest, healthiest, and strongest, and when the problem is at its simplest stages and still relatively straightforward to fix. Waiting for advanced or emergency circumstances implies a deteriorated state, with a host of secondary problems as well and a poorer chance of adequately addressing the issue at all, much less of restoring the patient to normalcy.

To solve a problem elegantly and thoroughly, don't wait for a crisis.

Jules also had to rely largely on the judgments of scientists and technologists, and the integrity of their devices, for the detection, assessment, and solution of the problem. It was presented to him in the form of graphs, charts, computerized images, and expert opinions, not in terms of something he could actually see or feel; and the results of the proposed "repair," even if things went perfectly, would at best be transparent.

But such characteristics are nothing unusual in modern life: the technological and sophisticated means by which we discover so many problems and endeavor to solve them are our plight—and blessing. It may be a perfectly lovely December afternoon in Boston, for example, and foul weather is the last thing on our minds. Yet satellites and computers enable analysts to warn that a band of moisture observed in the Gulf of Mexico will likely produce a major New England snowstorm two and a half days hence.

Jules decided to have the operation, which was successful, and he continues (knock on wood) to do well. He would of course have preferred business as usual, but that was not an option. Change of one kind or another appeared inevitable—and it would either be actively chosen or passively experienced. He reasoned that accepting the problem, and addressing it early and constructively, offered the best prospects—or, alternatively viewed, avoided the worst.

In this issue of *Technology Review*, physician Eric Chivian, in "The Ultimate Preventive Medicine," makes a similar case for the fate of the earth, and he goes beyond mere medical analogy. The worsening global environment, he argues, is itself a bona fide and enormous medical problem. Large-scale changes such as climate modification and the loss of biodiversity ultimately affect *us*, and where it hurts. So the time to recognize and begin addressing these conditions, with some extensive and in-depth treatments, is now—before the planetary patient, and the billions of dependent human patients (not to mention the earth's many other organisms), get further compromised and much more difficult to cure.

By going the active route, it seems to me, we might even be able to turn some of our present lemons into lemonade. Given the post-Cold War economic malaise and the consequent need for new applications of our scientific and technological talents, why not begin establishing an enormous collaborative program—a super Manhattan Project—entailing sustained, practical, international, interdisciplinary, and highly coordinated efforts to reengineer the way we use the earth's resources?

My own dream is for humanity to cleverly convert its polluting processes—that is, virtually all of our technological systems—into a vast and interconnected network that is nonpolluting simply because, as in nature, every output is a useful input somewhere else. This may sound overly grand, but we could start small and build, link by link, growing much as the Internet has so effectively been doing. Then again, grand is the scale we should be aiming for—as a worthy outlet for our diverse skills and as a healthful and sophisticated strategy for ensuring the survival and well-being of the earth's inhabitants.■

—STEVEN J. MARCUS

Letters

THE LIMITS OF AIR POWER

David Callahan's major assertion in "Air Power Comes of Age" *(TR August/September 1994)*—that air power has become the dominant force in future conflicts involving the U.S. military—is not realistic. American victory in war has most often been achieved through a careful integration and synchronization of our nation's air, land, and sea forces. In the Gulf War, air sorties targeted the Iraqi ground forces prior to the ground attack, but these enemy units were still at a high operational level when attacked and defeated by coalition ground forces. It was only after an integrated application of ground, air, and naval power by the theater commander that the Iraqi forces in Kuwait were routed.

Though the performance of precision-guided and stealth missiles is impressive, airplanes and precision-guided munitions have become expensive and are still vulnerable to countermeasures. Iraqi ground-based air defense systems forced the Air Force to conduct most of its attacks from altitudes that degraded the effects of the munitions utilized, both precision-guided and conventional. Pilots in Bosnia reported significant problems in identifying targets and had to conduct low-level attacks with conventional munitions because weather conditions handicapped the precision-guided munitions.

Also, once victory is achieved, land forces must be prepared to shift to operations other than war. From establishing provisional governments to providing humanitarian assistance to the peoples of defeated nations, land forces ensure that victory is made permanent by subsequent noncombat operations.

Beginning with General Washington's monumental victory at Yorktown, the U.S. military has recognized the essential truth that joint warfare is the key to victory, and continued application of that principle is even more important for future conflicts.

LIEUTENANT GENERAL PAUL E. BLACKWELL
Deputy Chief of Staff
for Operations and Plans
Department of the Army
Washington, D.C.

Perhaps if "Air Power Comes of Age" had been titled "Restructuring Defense: The Air-Power Case," I might have been less confused by the author's conclusions. Obviously, Callahan was only using the air-power debate as a springboard for critiquing the military forces' downsizing. In so doing he fell into the well-known trap of overestimating the effectiveness of air power.

It is dangerous to assume that future conflicts will duplicate the Gulf War. The unique combination of politics, terrain, and a six-month buildup period gave the United States an advantage that Iraq could not overcome. Although the Iraqis had access to some of the Soviet Union's most advanced weaponry, they did not always have the best. And Callahan failed to mention that Iraq's military is organized in a fashion that enhances internal security, not military competence.

Callahan assumes that the sole justification for having superior technology is the perceived technological competence of an opponent. But superior technology is also a force multiplier, which becomes especially important as U.S. forces are reduced.

Moreover, many of the programs Callahan argues against are intended to replace older weapon systems, like the B-52, which are well past their prime. Other programs, like the F-22, are intended to replace weapons that will be ready to be retired relatively soon. Modern aircraft can have a 30-year service life, but it takes 10 years or longer for their replacements to be designed and ready to fly.

JOSÉ M. PEREZ
Medford, Mass.

ACCURACY IN SMART WEAPONS

In his review of *Crusade: the Untold Story of the Persian Gulf War (TR May/June 1994)*, Jonathan Tucker deplores the "inaccuracy" of smart weapons, but his own figures show they made a tremendous contribution. Unguided bombs hit "only 25 percent of the time," "nearly half [the Tomahawks] veered off their mark," and "laser-guided munitions missed their targets with at least one bomb in four." An increase in kill probability from 25 to 50 to 75 percent is remarkable and is to be commended and encouraged. Such an improvement not only reduces the U.S. casualties but also reduces noncombat losses, about which he was concerned.

JOHN G. BARMBY
Vienna, Va.

OUR FUTURE IN SPACE

In "Fly Me to the Moon: An Interview with Joseph G. Gavin, Jr." (*TR July 1994*), Joe does his usual excellent job of describing the Lunar Module Program. While he was working with his team at Grumman, I was in charge of the Command and Service Module Program at what is today Rockwell International. The interviewer asks, "Could Apollo be done today?" In my opinion, the answer is "not in the near future." The USSR's stunning launch of Sputnik, Kennedy's embarrassment in the Bay of Pigs, and the American zeal for exploration and fear of lagging behind technologically combined to create an ideal climate for initiating the $24 billion program ($80 billion in current dollars).

Today we are subsidizing and cooperating with the Russians, rather than competing with them. I have doubts that we could sustain a joint 15- to 20-year piloted space program: one of the partners would undoubtedly pull out for financial or political reasons. (Although we worked with the USSR on a successful Apollo-Soyuz program during the Cold War, I believe success resulted from driving the program through in three years within budget.) I believe NASA has the general support of the president, but more for its foreign-policy and commercial advantages than for exploration or science. Congress is pressed so hard for dollars that the NASA budget is expected to fall for the next few years, and though still excited about exploration, the public can wait until the economy is better and the price comes down.

At some point new technologies will reduce transportation costs and the promise of commercial rewards will spur new interest in a return to the moon, although I don't think we will go unless we plan to stay indefinitely. This will happen after an extensive number of probes and robotic landers determine what materials are economically available, and after the mining and manufacturing processes needed for humans to survive (and prosper) are developed.

DALE D. MYERS
Deputy Administrator, NASA (retired)
Leucadia, Calif.

I worked for Joe Gavin at Grumman as the Lunar Module Program's engineering manager, where we learned firsthand the miracle that can be wrought by ordinary people inspired by extraordinary challenges to set new standards for dedication, quality, and accomplishment. At the risk of appearing to disagree with my distinguished colleague and mentor, however, I would like to put in a good word for the controversial Space Station Program. In this I am admittedly biased, having been for two years president of Grumman's Space Station Integration division where I struggled to help NASA arrive at a practical, affordable design and a workable management system.

The original concept of the station was admittedly far too grandiose, as NASA tried to make it all things to all people. Yearly budget cuts by Congress forced frequent redesigns and wasted effort. Major segments of NASA never accepted the Apollo-style concept of central program management. The subservient role of the international partners limited their enthusiasm.

With time (and money), most of these problems have finally been corrected. Learning to live and work in space has now become the single primary objective—one basic to any long-term human space exploration and aimed at occupying space, not just visiting. Scientific experimentation and materials development are valuable secondary objectives.

A simplified design for the station should prove more practical. And the inclusion of Russia has enhanced the international scope of the program and brought in new hardware and experience. Only the yearly funding problem remains, threatening further budget cuts, redesigns, and resulting cost increases.

The alternative—dropping the program—would mean deliberately ceding primacy in manned space to other nations. That's an unattractive option given our enormous investment and the benefits that have flowed to our economy from space technology.

THOMAS J. KELLY
Huntington, N.Y.

Joe Gavin indicated that cost came third (after performance and schedule) in the Apollo Program. I was the project manager of the command and service module on the Apollo Program, the project manager of the orbiter on the Shuttle Program, and the director of the Johnson Space Center during the early stages of the Space Station Program. What Gavin said about Apollo is exactly correct, but I would note that with the shuttle, cost was second and on the space station, cost is first.

If we are going to explore space in a more permanent manner than we did with Apollo, we need a space station. In the past 30 years the United States has accumulated more than 6 person-years of space flight. With a space station, we'll obtain that amount each year.

Furthermore, if we are going to have a human exploration of Mars, we are going to have to assemble structures in space.

The low earth orbit of a space station is a good place to do this. The launch vehicle would be too large if we did not provide assembly capability in orbit.

AARON COHEN
Professor of Mechanical Engineering
Texas A&M University
College Station, Tex.

RULES OF THE ROAD

With regard to "Cars, Civilization, and World Peace" by Thomas L. Magliozzi (*TR May/June 1994*): Click (or is it Clack) rightly suggests that the general health and civility of our society can be measured by driving a car in an average city. If we could create an urban traffic environment in which all drivers knew and displayed respect for the letter and spirit of each regulation, as well as unflagging courtesy for fellow commuters, occasional tourists, distracted pedestrians, and wayward pets, world peace might surely follow.

I offer a few modest additional proposals toward that end: 1) Refrain from dining behind the wheel when flatware is required; 2) Remember whether the gas cap is on the left side or the right side of the car; 3) Undergo hypnotic therapy to induce reflexive turn-signal use; 4) Shave and/or apply all make-up prior to opening the garage door; 5) Know how to ask for understandable directions; 6) Give understandable directions when asked; 7) Restrain all passengers—whether animal or human—using an approved belt, safety seat, or ventilated box; 8) Always position the driver's seat so the focal point is over, not under, the top of the steering wheel; 9) Remove all vision-obstructing baseball caps, plush animals, air fresheners, signs, stickers, tissue boxes, portable speakers, fuzzy dice, and hula dancers from the vehicle dash, deck, and rear view mirror; 10) Pull completely off the road and park when using a cellular telephone to explain why you are going to be late. By adopting the preceding behaviors, practitioners of vehicular karma might admonish others with the maxim, "As goes traffic, so goes the world."

GEOFF SUNDSTROM
American Automobile Association
Heathrow, Fla.

NUCLEAR ETERNITIES

In his letter promoting the use of nuclear power, Mujid S. Kazami (*TR May/June 1994*) asserts that nuclear stations provide South Korea with energy at a lower cost than coal- or oil-burning plants. Such accounting ignores the real costs of decommissioning nuclear plants and the environmental and health effects resulting from the creation of radioactive substances. Kazami mentions such effects of fossil-fuel emissions but omits those of nuclear power. A nuclear station operates for only 30 years, but the waste it creates persists for millennia. Surely the cost of such lengthy waste-isolation exceeds that of constructing and operating the plant that creates the waste.

PAUL BORNEO
Shutesbury, Mass.

CREATION OF SPECIES

I must respond to Leo Marx's review in the May/June issue of my book *The Evolution of Progress: The End of Economic Growth and the Beginning of Human Transformation*. Marx accuses me of reducing the rich and complex idea of progress "to a tidy formula: progress=economic growth." But the book is specifically about *material* (that is, economic) progress, not about other kinds of progress, the existence and importance of which I noted. Economic progress does not stand alone; neither is it unworthy of serious analysis.

My book then earns a "conspicuous place in the historians' storehouse of grotesque fantasies" by anticipating "the creation of a new species." Strong stuff, except that I anticipate no such thing. Marx plucked his contention from my sentence, "The creation of a new species is, of course, speculative." Equating speculation with anticipation is a definitional leap. Some current research suggests that speciation may be possible in the distant future—I neither predicted nor endorsed that result. Anyone anticipating results in a lifetime is likely to be disappointed (or relieved). Anyone claiming to exclude them forever would be foolish.

C. OWEN PAEPKE
Phoenix, Ariz.

ARTIFICIAL ORGANS: NOT ONLY A TECHNICAL CHALLENGE

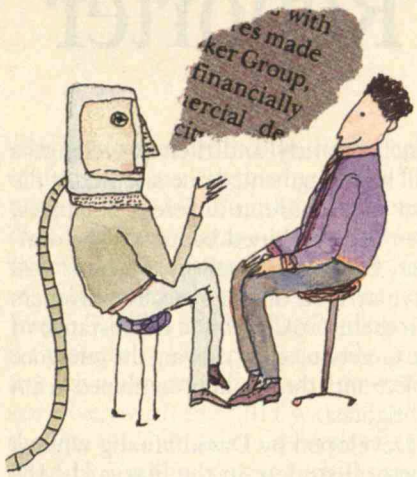
My colleagues and I read "Making Artificial Organs Work" (*TR August/September 1994*) by Stella Jones Fitzgibbons with great pleasure. Tremendous strides have been made in artificial internal organs since the development of kidney dialysis in the 1950s. Our own experience in the field has been tremendously rewarding and humbling. This research not only addresses artificial-organ development but furthers our understanding of the complex interaction between the failing organ and the body's struggle for homeostasis. Unfortunately, the cost of R&D is high and the risk/benefit ratio is always unknown initially. An unsuccessful trial of a device is not reason to halt development, but an indication to rethink the problem and reconsider modifications.

Fitzgibbons clearly illustrates how the technical aspects constitute only a part of the difficulty of artificial-organ research. Economic and regulatory restrictions as well as an increasingly litigious society threaten to stall the advances of medicine. Investigators and industry must learn to collaborate with the Food and Drug Administration and other regulatory bodies in order to avoid costly and nonproductive use of limited resources. Likewise, the FDA must be responsive to patients' needs rather than political or popular trends.

J.B. ZWISCHENBERGER
A.B. SANKAR
W. TAYLOR
University of Texas Medical Branch
Galveston, Tex.

WITH INFO AND DATA FOR ALL

At the end of "Travels on the Net" (*TR July 1994*), Steven Steinberg says that networks should be widely accessible and their content should not be censored. The Australian Science and Technology Council (ASTEC) recently submitted a report to the government that may disturb Steinberg on those counts. Broadly speaking, the report recommended that Australia's network not be publicly funded, and that access to it be on a pay-by-byte basis. However, ASTEC's proposals are not set



in stone, and may be modified in the face of criticism from the network-using community, which is voicing concerns similar to those Steinberg raises.

Critics are concerned that businesses whose international competitors have access to publicly funded networks will be severely hampered. Among individuals a gulf between information haves and have-nots could be socially divisive. Users are also concerned about what private networks will consider acceptable content, since many sites on AARNet, Australia's arm of the Internet, already refuse to transmit material such as that found in the Usenet discussion group alt.sex. As Steinberg points out with respect to service providers such as Prodigy, the result of content-based censorship is a decrease in the energy and enthusiasm of those who might speak and thus in the utility of the service.

The much hyperbolized information superhighway can hope to live up to expectations only if the metaphor is taken seriously. Such facilities should function as public utilities, publicly funded through taxes like highways, and considered common carriers like the telephone network. And if we want our future society to be conducive to free enterprise and free speech, the public data highways will need to carry any content, regardless of how controversial. Given freedom to speak and a public platform, users of future data highways will find such systems as culturally rich and diverse as users of the Internet find it today.

ELIZABETH REID
Communications Studies Department
Royal Melbourne Institute of Technology
Australia

Regarding "Seven Thinkers in Search of an Information Highway" (*TR August/September 1994*), I share in the hope voiced by Mitchell Kapor that the system will be "open, inclusive, egalitarian, and decentralized." This hope prompted me to introduce the National Communications Competition and Information Infrastructure Act of 1994. In June the House of Representatives overwhelmingly approved the bill by a vote of 423 to 4. Representing the most sweeping overhaul of the 1934 Communications Act, it will, if passed by the Senate, help pave the information superhighway.

I share moderator Herb Brody's fear that this project runs the risk of further dividing society into haves and have-nots. Thus my legislation mandates that a federal-state joint board be created to implement a plan requiring all telecommunications providers to help preserve and expand universal service. Just as important is a provision that seeks to hook up schools to the digital superhighway. These learning links will provide our schoolchildren with access to information that goes beyond merely movies-on-demand. Without such provisions, the information superhighway will become a narrow, private, toll road.

EDWARD J. MARKEY
U.S. House of Representatives
Washington, D.C.

THE CARE, BREEDING, AND REPLACEMENT OF PRIMATES

If primates are currently indispensable to research, the research community should breed its own animals. As Deborah Blum points out in "Hunting for Mangabeys" (*TR August/September 1994*), such breeding makes sense scientifically because researchers need to know each animal's full history. And this breeding should take place in the United States, not overseas, where in the absence of scrutiny wild animals can be labeled captive-bred or reared in substandard conditions.

Blum's story has two additional lessons for scientists and funding agen-

Continued on page 79

MIT Reporter

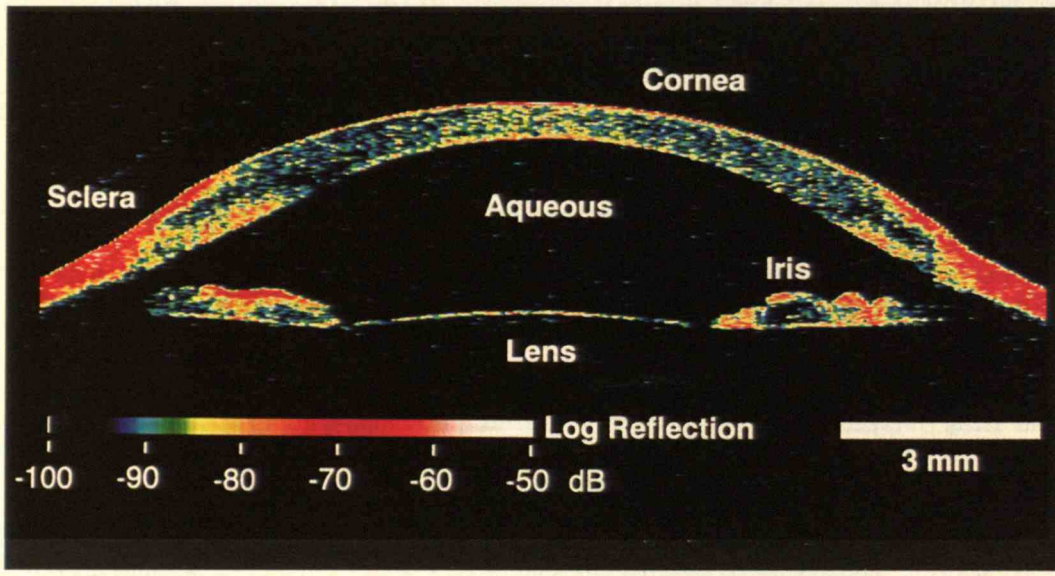
Medical Imaging with Light

Technologies such as x-ray, ultrasound, and magnetic resonance imaging (MRI) have become nearly indispensable in the medical field. Adding to this arsenal of diagnostic tools, researchers at MIT and other centers have developed a new system called optical coherence tomography (OCT) that in certain instances can obtain images of structures as tiny as 10 microns, roughly 1/2,500th of an inch. With such microscopic resolution, OCT might be used to diagnose glaucoma, melanoma, and atherosclerosis, among other diseases.

OCT is based on the principles of low-coherence interferometry, in which two identical beams of low-coherence light—which consists of many frequencies—are transmitted from a source. One beam strikes the object to be examined, and the other a reference object whose distance from the source is known. The waves bounce off their respective objects and return to the source, where they combine. If the target object is at the exact distance from the source as the reference object, then the combined beam will be bright because the two reflected beams will have arrived synchronously and their wavelengths will have augmented one another. If the two objects are at different distances, then the combined beam will be dimmer, because the reflected beams will have arrived out of sync. Researchers can therefore determine the distance of the target object by moving the reference object until the resulting combined beam is brightest.

Developed by David Huang while a doctoral student in the Harvard-MIT Division of Health Sciences and Technology (he is now a resident in ophthalmology at the University of Southern California), and James G. Fujimoto, a professor in the Research Laboratory of Electronics and the Department of Electrical Engineering and Computer Science at MIT, OCT extends the principles of low-coherence interferometry to obtain cross-sectional images of tissue made up of several layers that reflect different amounts of light. In OCT, low-coherence infrared light is split into two identical beams: the first beam is focused at tissue and the second beam at a reference mirror. The tissue's reflecting layers bounce back portions of the first beam to a photosensor while the mirror reflects the light from the second beam toward the same device. The reflected light beams meet at the photosensor, which measures the brightness of the resulting combined beam. The reference mirror is then moved slightly and more light is transmitted; repeating this process numerous times enables a computer to determine the depths of all the reflecting tissue layers at the spot where the light source is focused. Next, the OCT device focuses the source at an adjacent location of the tissue and repeats the process of moving the reference mirror many times while transmitting light. From the depth measurements at the different locations where the light was focused, the instrument can construct a cross-sectional image of the tissue.

One feature of OCT is that the technology uses inexpensive fiber optics and standard optical components, says Eric A. Swanson, a senior staff member at MIT-affiliated Lincoln Laboratory, who was also a key member of the research team. The resolution is far higher than that of ultrasound, and the OCT technique does not require patients to lie still for long periods in a claustrophobic chamber, as they must for MRI scans. OCT also transmits harmless infrared light (the power conveyed is only about 175-millionths of a watt); by contrast, x-rays can damage the tissue being



A new medical imaging technology based on beams of light produced this cross-sectional image of part of a healthy human eye. The picture reveals that the sclera (the eye's white part) reflects more light (indicated by red) than the cornea does. The technique could be used to study problems in the eye.

PHOTO: JAMES G. FUJIMOTO

imaged. But this feature also handicaps the technology, because infrared light cannot penetrate deeply into the body.

Not surprisingly, some of the first applications being investigated involve the eye, through which infrared light can pass easily. Indeed, according to Fujimoto's research collaborators at Tufts University School of Medicine, Carmen A. Puliafito (director of the New England Eye Center) and Joel S. Schuman (director of the center's glaucoma service), OCT might enable the early detection of such eye diseases as glaucoma and macular degeneration—two of the leading causes of blindness among the elderly—and macular edema (swelling).

Diagnosing Glaucoma

In glaucoma, which affects millions worldwide, increasing pressure inside the eye results in a decrease in the thickness of the retinal nerve fiber layer at the back of the eye. Ophthalmologists now use intraocular pressure measurements, examinations of the optic nerve with an ophthalmoscope, and measurements of a patient's visual field to diagnose glaucoma. But intraocular pressure measurements do not reliably predict disease progression, the resolution obtained in ophthalmoscope exams is relatively poor, and up to 50 percent of the retinal nerve fibers may erode before there is any measurable loss of a patient's visual field.

If OCT could provide detailed images of the retina, the thickness of that layer could be determined, resulting in glaucoma detection so early that treatment—drug therapy or surgery—could be initiated sooner. That could minimize any loss of vision. The MIT-Tufts research team has recently commenced a set of clinical eye studies involving 700 subjects.

Whether OCT can be used for other parts of the body remains a question. To try to image further into turbid tissue, researchers in the Biomedical Engineering and Instrumentation Program at the National Institutes of Health, working independently from the MIT-Tufts researchers, are experimenting with a light of longer wavelengths (up to 1,500 nanometers, or billionths of a meter) than Fujimoto's light source (approximately 840 nanometers). The rationale of NIH researchers Robert Bonner, Joseph Schmitt, and Michael Yadlowsky is that light of longer wavelengths scatters less when passing through dense tissue. Even with the NIH wavelengths, though, OCT images to a depth of only about 1.5 millimeters in turbid tissue. Still, according to Bonner, that might be enough to evaluate skin lesions to determine whether they are cancerous. Analysis now requires a biopsy of tissue.

Other researchers at the Massachusetts General Hospital Wellman Laboratories, working in collaboration with Fujimoto, are investigating the possibility of incorporating OCT in endoscopes, instruments that consist of fiber optics and are used to visualize the interior of hollow organs such as the colon. An endoscope can see only surfaces, but, when combined with OCT, it might be able to image beneath the surface—even one that is turbid—and produce, for example, cross-sectional pictures of plaque inside coronary arteries.

So far one company that declines to be named for competitive reasons has licensed the OCT technology, planning to sell it for an undisclosed ophthalmic application. The Tufts researchers predict that the first commercial instrument will be available within two years.

—*Alden Hayashi*

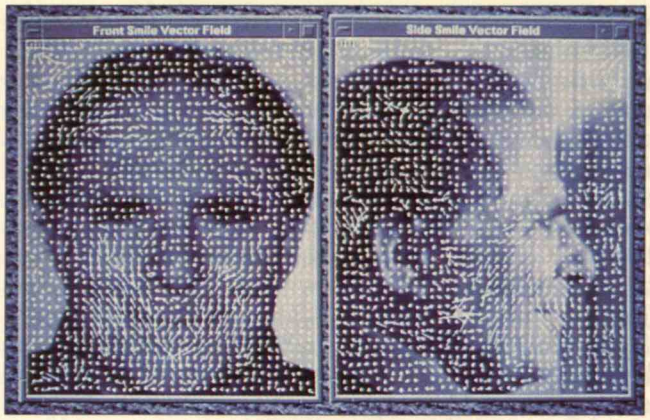
The Face Is Familiar

Some years from now, travelers boarding an airplane might be scanned by a sophisticated electronic eye that looks at their faces while searching for known terrorists. Following a crime, police might use a similar computerized face-recognition system to identify apprehended criminals. Eyeing them for a second, the device could pull up relevant police records. The nation's border patrols, too, could employ such devices to screen for aliens and smugglers trying to enter the country. Even now, the

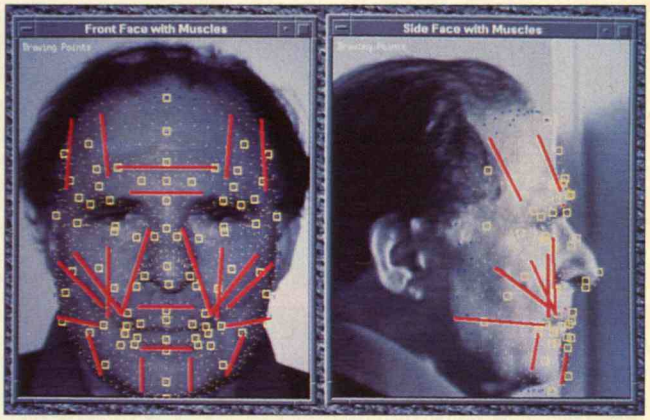
government of Mexico is considering building such a system to prevent double balloting by its voters.

In cluttered rooms at MIT's Media Lab, researchers are tweaking and testing an experimental face-recognition system. Called Photobook, the image-scanning device can distinguish a particular face using a database of more than 7,500 head-on "mug shots." The system does this by treating an image of a face as a grid of data and analyzing it in terms of its "information content."

Photobook first locates that grid in the larger array of pixels—dots—making up a computerized photograph. The system scans the overall image for a pattern that roughly resembles a model, stored in its memory, of a general face. (That model is a composite of all the faces in Photobook's database.) Then, having isolated the face, the computer analyzes it as a whole: Photobook determines how the various features, such as eyes, nose, and mouth, relate to one another in terms of their relative distances.



MIT researchers have developed software that measures facial motion (shown as tiny arrows, left), which they use to figure out exactly how muscles move (muscles appear as lines below). Such information enables the software to determine people's expressions and aids in face recognition.



The system next looks for mathematically distinctive characteristics of individual features; inventor Alex P. Pentland, an associate professor of media arts and sciences, draws on the German word for "own" to collectively call these features "eigen-information." He points out that they may not be limited to structures such as eyes, lips, and hair: just as people may recognize the distinctive look of someone with a chiseled nose and strong chin, the computer can pick out, say, a forehead and cheekbones of unusual dimensions. Taken together, someone's features are "markers" that denote the uniqueness of a face, Pentland says, which the system compares with the individual faces in its database to reveal the person's identity.

Photobook does quite well when asked to "verify" a person's identity—prove that someone is who he or she claims to be. In less than one second, it can verify a person with roughly 98 percent accuracy. It falsely rejects someone less than 2 percent of the time and falsely verifies someone less than 1 in 10,000 times. Other experimental automated systems, including those that listen to people's vocal patterns, measure their hand prints, or compare the retinal patterns of their eyes, turn in slower and less accurate performances. Only digital fingerprint scans are virtually flawless with respect to false verifications.

Yet when asked to "identify" someone—in other words, when no information is given about who a person purports to be—the fingerprint system cannot complete the task in 9 out of 100 test cases. In one test of 200 random faces, however, Photobook accurately identified individuals more than 95 percent of the time. It even stood the test of some trickery: sunglasses, new hairstyles, and changes in position and expression did not throw the system off.

Babock Moghaddam, a graduate student in electrical engineering and computer science, is now adapting the Pho-

PHOTOS: I. ESSA, T. DARELL, A. PENTLAND

tobook system to recognize the face of someone moving in front of a video camera rather than at a dead stop. This is a much more gnarly problem. The question becomes how to pick up and track a face that may be lost in a sea of "visual noise" such as a crowd.

For his system, called Face-Rec, Moghaddam is devising software that can detect a person's presence, based on the way a body moves. Then the computer zeroes in on the head, using other rules. "For instance," Moghaddam says, "you don't generally look for a head on the floor." Finally, the system uses the Photobook process to track and identify the face.

Pentland's research team is also trying to give Photobook the ability to interpret active facial expressions, since such a change can alter the image the computer is trying to analyze and thus make identification trickier. Irfan A. Essa, a postdoctoral research associate at the Media Lab, uses a video camera to track a person's face as he or she smiles or frowns. Associated software includes a structural model of a face, with information on which muscles lie where, how they contract and relax, how eyes and jaws move mechanically, and so on. Essa is also taking the idea a step further: he is enabling the system to produce moving images of faces that can, say, laugh or pout. Although the results are still primitive, in the future such a system might, upon request, generate a realistic animation of a person with a certain mood or expression.

Pentland says he's received a number of inquiries about Photobook, adding that most parties have requested anonymity because their interest is at an early stage. Representatives of four U.S. states have talked with him about using the system for checks on drunk drivers and people suspected of fraud in obtaining, say, multiple driver's licenses. And the Saudi Arabian government has approached him about a system for checking voters.—*RICHARD LIPKIN*

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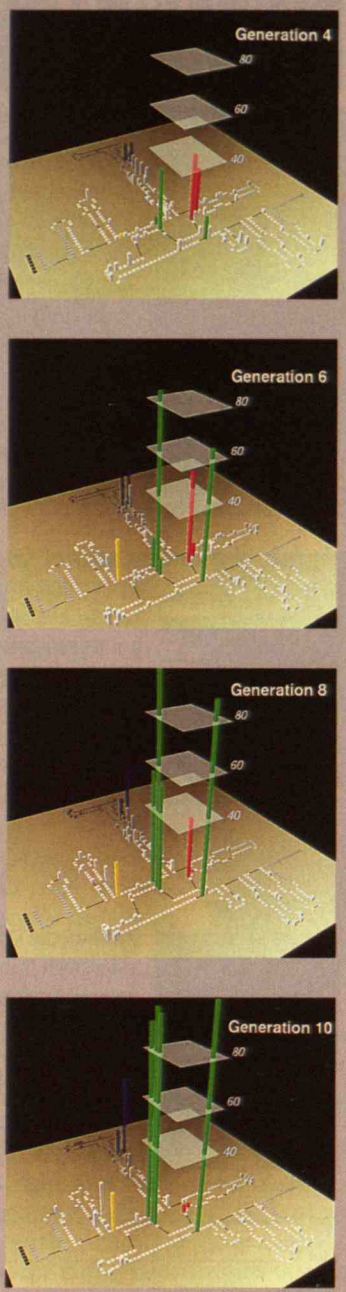
Test-Tube Evolution

Imagine if scientists could apply Darwin's theory of natural selection to substances in a test tube, churning out brand-new molecules with shapes and functions previously unknown and testing their usefulness in a fraction of the time nature takes to weed out the fittest survivors.

That's exactly what's happening in about a dozen laboratories around the country: "We're talking about nothing less than molecular design through evolution," says Gerald Joyce, associate professor of chemistry and molecular biology at the Scripps Research Institute in La Jolla, Calif. The immediate application of this promising scientific process, called "directed molecular evolution," is in developing new drugs that may be used to prevent blood clotting in heart disease or to fight HIV infection.

Here's how test-tube evolution works. Let's say you want to create a drug that binds strongly to a particular bacterium. Using standard lab techniques, you would take a particular molecule that has shown some binding ability and make many copies, each of which share the same basic structure but have slight molecular variations. Let's call this batch X. Then take millions of bacterium molecules, all of which are identical. Call this batch Y. Now mix the two populations together. After a few minutes, you'll find three groups of molecules: a bunch of single X molecules, a bunch of single Y molecules, and a new group of Z molecules. Study the Z molecules by pulling them apart into their X and Y components and discerning which variations of X molecules bound best to the Y molecules.

Introduce more variations in the most effective X molecules and repeat the trial over several generations. Each time, discard the X molecules with variations that keep them from binding well, and keep those that form the strongest bonds with Y molecules. Before long you've got a generation of molecules with binding abilities that far exceed those occurring naturally.



Human-directed molecular evolution does not always occur at a steady pace. As this DNA-snipping ribozyme evolves, several of its nucleotides (represented by green bars on these maps of the molecule's structure) completely adopt a mutation after only 10 generations. The nucleotides shown as yellow and purple bars incorporate change more slowly, while the ones shown in red mutate and then revert back to their original form.

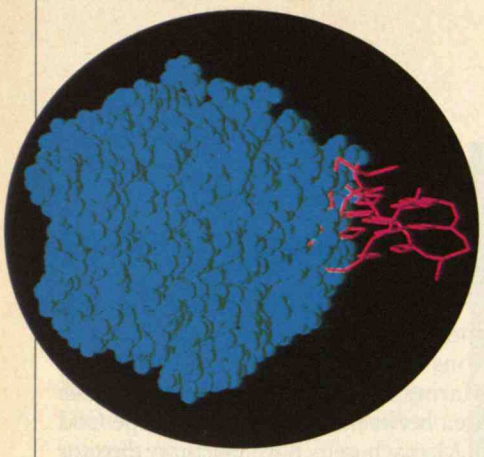
So far, directed molecular evolution has been most successful with chains of nucleotides, the compounds that make up RNA and DNA, because it is relatively easy to assemble mass numbers of them, in so-called "libraries," with the necessary mutations.

RNA and DNA are composed of nucleic acids, of which there are only four basic building blocks: A, C, T, and G (adenine, cytosine, thymine, and guanine). Using a machine called a DNA synthesizer, it is possible to generate copies of any variety of nucleic acids. You sit at the machine and tap out on a keyboard any string of nucleotides you wish to test, and the machine assembles the nucleic acids in sequence. If you're interested in the behavior of a particular chain mix—say AAAAAAA—the DNA synthesizer gives you the power to introduce mutations where you want, turning the chain into AAAAGAA, for example. "You can produce millions and billions of copies of these things in a couple of hours," says Joyce.

In research conducted with his colleague Amber Beaudry at Scripps Research Institute, Joyce carried out one of the cornerstone experiments in directed molecular evolution: not only did he "evolve" a new molecule from a ribozyme (an enzyme made of RNA), but the new molecule performed a new function. Ribozymes have the ability to cut themselves out of larger molecules of RNA. Joyce wanted to produce one that could also snip DNA. His hope is that such an enzyme could take on therapeutic value in medicinal form, chopping up the DNA of an unwanted virus that is invading the body to keep it from attacking cells and replicating itself, for example.

Joyce started by finding existing ribozymes with at least some propensity for cleaving DNA. The naturally occurring ribozymes were so poor at slicing up DNA that Joyce initially accepted as a success any ribozyme that could cut a strand of DNA in an hour. Then he added mutations to this initial crop. Two years and 27 generations later, Joyce has ribozymes that snip DNA in

PHOTOS: LEHMAN, JOYCE/CURRENT BIOLOGY



Directed molecular evolution produced an anticoagulation drug (shown in red) that blocks a site on the protein thrombin (blue) where other agents bind to form blood clots.

less than five minutes. "This is a new model for drug discovery," claims Joyce.

Before test-tube evolution, "no one understood that nucleotides would provide such good and versatile shapes for drug development, because in nature, they're not used that way," says Larry Gold, a biology professor at the University of Colorado and executive vice-president for research at Nexagen, a biotech company in Boulder, Colo. Nexagen is using directed molecular evolution to work on a variety of medical tests and treatments, including those with potential in combatting HIV. For example, the company has used the technique to develop nucleotides that block some of the proteins believed essential to the spread of HIV once it is inside the body. Nexagen experiments indicate that human cells in a culture of the virus-blocking nucleotides have a 100,000-fold lower susceptibility to HIV infection. The company is working on possible ways to deliver the nucleotides to the body through gene therapy.

At Gilead Sciences, a biotech company in Foster City, Calif., test-tube evolution is being used to develop a nucleotide-based anticoagulant drug that blocks thrombin, a blood-clotting protein. The compound binds selectively and with high affinity to the precise location on the thrombin molecule at which other agents in the blood must attach themselves to complete the clot-forming process, according to Steven Coutre, a research scientist in vascular biology at Gilead Sciences. Unlike other drugs that affect the whole thrombin molecule--and along with it the protein's beneficial properties such as stimulating cell proliferation and growth—the compound affects only thrombin's blood-clotting activity.

Michael Riordan, chairman and president of Gilead, says the anticoagulant could be used in treating heart disease, during heart bypass operations, or to reduce blood clots in the brain that may cause stroke. The drug has been tested on animals, including monkeys and dogs. "Traditionally, it would take years just to come up with molecules that have new shapes you want to test out," says Riordan. In contrast, it took the company just a few months to develop and test many generations of the thrombin-blocking molecules.

Other scientists are exploring ways to expand the benefits of test-tube evolution from nucleotides to more complex molecules such as proteins. For example, Frances Arnold, an associate professor of chemical engineering at the California Institute of Technology, used the technique to create a new form of a protein enzyme called subtilisin. Because subtilisin is an enzyme that "chews up proteins," she says, it can be used to break up large proteins into small building blocks, which in turn might be combined in different ways to create new drugs.

Using a DNA synthesizer, Arnold replicated the amino-acid chains of the gene that carries instructions for making subtilisin. She then created many copies of the gene, introducing slight variations in each batch, and planted them in host bacteria that would produce various forms of the protein according to the genes' instructions.

One problem with naturally occurring subtilisin is that it survives only in water, not in organic substances, such as those used in drug production. By repeatedly identifying the genes that produced the most desirable form of subtilisin and introducing new variations, Arnold created a version that was not only able to function in an organic solvent but was also more than 250 times as active as the original. "This shows that you could make proteins that are amazingly flexible in a foreign environment," she says, and it demonstrates the power of molecular evolution to build on what nature has already created.

—*MUBARAK DAHIR*

Underwater Wildlife Sanctuaries

To marine biologists like Peter Auster and Richard Malatesta, the idea is simple: since we protect terrestrial animal species by creating wildlife sanctuaries, why not adopt a similar strategy to protect marine ecosystems? As sensible as it sounds, a plan proposed recently by Auster and Malatesta for a marine preserve, or "experimental marine replenishment zone," as they call it, in the North Atlantic, has little precedent worldwide. Nor has it been welcomed by the beleaguered New England fishing community.

As is true in many of the world's prime fishing locales, fish populations in the North Atlantic are dwindling to unprecedented new lows for most species, according to Terry Smith, research coordinator for the New England Fishery Science Center, which gathers statistics about fish populations.

One crucial question before the fishing community is the extent to which modern techniques of trawling and dredging, in which nets and cages are dragged along the ocean bottom, have damaged underwater ecosystems that sustain fish and other marine life. "We don't know if current fishing methods are akin to plowing a field or whether we are ruining the bottom," says Patricia Fiorelli of the New England Fishery Management Council, the group that manages fishing in New England waters and that will consider Auster and Malatesta's plan.

Auster, a professor at the University of Connecticut, says such uncertainty underscores the need for a research-sized marine replenishment zone. "Just as we use national wildlife refuges as a reference point from which to judge human impact, we need to do this for marine habitats," he maintains.

Malatesta, Auster's colleague and an instructor at the Sea Education Association, a college of oceanography in Woods Hole, Mass., adds that today there is virtually no underwater spot on the North American continental shelf that is not

PHOTO: GILEAD SCIENCES

trawled for fish at least once a year. "Some areas are dragged for fish four or more times annually, he says. "From an ecological standpoint, this situation is in many ways worse than on land."

Auster and Malatesta are pioneers in the study of what they call marine microhabitats—the pieces of ocean floor that include sand depressions and tunnels created by marine animals in which young fish can hide from predators, and that support a mix of sponges, anemone forests, and other aquatic life.

Last summer Auster and Malatesta used deep-sea robots to compare relatively untrawled areas off a protected island in Maine with heavily trawled areas. The difference was striking: the trawled areas revealed not just fewer fish but also the loss of so-called habitat structure from the ocean floor.

The team's earlier research showed similar effects. In one experiment, Auster and Malatesta piled shells in one area on the ocean floor off the coast of Stonington, Conn. They discovered that the built-up sea bottom supported significantly greater numbers and types of fish and other marine life than more barren neighboring areas.

As Auster explains, many of the management controls currently in place or under consideration by the fishing industry, such as restricting a fishing vessel's permitted time at sea or instituting temporary bans on trawling, don't allow enough time for slow-growing species like sponges to rejuvenate themselves on the sea floor. A marine preserve, or "no-take zone," in contrast, might restore these habitats, allowing significant numbers of young fish to grow to adult size before swimming away to be harvested elsewhere. "What we are asking," Malatesta says, "is simply to see under research conditions what an area would look like if it were not dragged for one to five years."

Auster and Malatesta's work takes on urgency amid a mounting crisis in the world fishing industry. The United Nations' Food and Agriculture Organization (FAO) now considers most fish populations in international waters either "fully exploited," "overexploited," or "depleted." According to the FAO, the number of large vessels fishing the world's oceans more than doubled between 1970 and 1990, from 585,000 to 1.2 million.

The idea for no-take zones could fit into existing U.S. legislation. Since 1972, Congress has designated 14 marine sanctuaries in U.S. waters. But, Auster stresses, these so-called sanctuary areas place few, if any, restrictions on fishing. In deference to fishing industries, he says, the current level of fishing is almost always "grandfathered in" when such sanctuaries are established.

One protected area in which Auster and Malatesta hope to beef up restrictions is the Stellwagen Bank National Marine Sanctuary, an 842-square-mile area between Cape Ann and Cape Cod in Massachusetts Bay. Sanctuary director Bradley Barr, who is working with Auster and Malatesta to complete sonar analyses of sediments at the ocean bottom and provide a picture of which areas in the Stellwagen bank are heavily fished, says he is receptive to the idea of an experimental replenishment zone within Stellwagen or elsewhere. "A sanctuary could help provide some answers," he says.

While modern technology has created a streamlined and efficient fishing fleet, Barr says, little attention has been paid to what he calls "conservation engineering." Auster and Malatesta's work, he says, "can provide important data that could lead to the development of new types of scallop dredgers or net designs that might be less harmful to these fragile ecosystems."

As for enforcement, Malatesta maintains that it would be relatively easy to demarcate and monitor a small research plot of up to 20 square miles. But he admits that employing the scheme "on a scale large enough to make a difference to overall fish populations would pose formidable logistics."

Still, Auster calls any discussion of logistics premature. "Theoretically, we could bring legal or social pressure to bear," he says. But first we need to prove the benefits of creating true sanctuaries because, he says, "we need the support of the fishing community to make any such scheme a reality."—*SETH SHULMAN*

ILLUSTRATION: ANDREA SUTTON

Reducing the Risks of Ultrasound

Eliminating routine ultrasound screening of women with low-risk pregnancies could save the nation half a billion dollars per year, say medical researchers, without significantly increasing the frequency of abnormal births.

Approximately 70 percent of all pregnant women in the United States now undergo routine ultrasound evaluation. The exams are usually performed once between 15 and 22 weeks of gestation and again between 31 and 35 weeks to provide obstetricians with information about fetal viability, age, size, the location of the placenta, the amount of amniotic fluid surrounding the fetus, and some types of birth defects. When an anomaly is suspected, more targeted exams help diagnose defects of the fetal head, spine, chest, limbs, and heart.

But despite the procedure's apparent usefulness and growing popularity, many physicians now say that the benefits of routine testing, especially for low-risk pregnancies, may not outweigh the costs. A recent study supported by the National Institute of Child Health and Human Development concluded that among low-risk pregnant women, ultrasound imaging, or sonography, does not improve perinatal outcome. The study, known as Routine Antenatal Diagnostic Imaging with Ultrasound (RADIUS), involved more than 15,000 low-risk pregnant women, making it the largest controlled trial of its type ever conducted. The results, published in the *New England Journal of Medicine*, showed that 5 percent of babies delivered to healthy, low-risk women had significant problems at birth—ranging from facial-nerve injury to fetal death—whether given ultrasound exams or not.

The conclusion seems counterintuitive given that sonograms were better able to detect abnormalities than other screening techniques such as blood tests used in the control group. In fact, ultrasound caught 35 percent of the anomalies that appeared at birth while the techniques used in the control group detected 10 percent of the eventual problems.

But, according to the authors of the RADIUS study, the detection of anomalies by ultrasound screening did not reduce the actual frequency of adverse perinatal outcome for several reasons. First, more than half the anomalies in the ultrasound screening group were detected after 24 weeks of gestation, when legal abortion is not available in most states. Second, two-thirds of the women in whom fetal anomalies were discovered through ultrasound screening chose to continue their pregnancies. And third, indications of significant problems led some women in the control group to abort their fetuses. As a result, the abortion rate in the ultrasound-screening group (0.15 percent) was not significantly greater than the rate in the control group (0.12 percent).

Acknowledging that patients may still want to obtain sonograms for assurance that the fetus has no congenital defects, the RADIUS study authors maintain that any such benefits of ultrasound screening must be weighed against the unnecessary anxiety and subsequent risks of overtreatment associated with false positive diagnoses.

The authors also contend that routine ultrasound screening adds considerably to the cost of prenatal care. They calculate that if ultrasound exams were prescribed only for women with high-risk pregnancies—some 20 percent of the 4 million women who become pregnant each year—and for the remaining 80 percent only when problems arose, the country would save at least $500 million a year, at $200 per scan.

Such calls for caution in using ultrasound date back at least a decade. In 1984, medical experts participating at a major conference on diagnostic imaging in pregnancy sponsored by the National Institutes of Health and the Food and Drug Administration concluded that ultrasound examination should be performed only for a specific medical indication. In a consensus statement, the group resolved that the data on clinical efficacy "do not allow a recommendation for routine screening."

At the same time that the RADIUS study was published, the American College of Obstetricians and Gynecologists issued a statement reinforcing advice it made in 1988, that "ultrasound is not necessary for every woman or in every pregnancy." Ultrasound may be indicated in cases where there is reason to suspect a problem or where additional information about the fetus is needed, according to the college. Indications can include women with bleeding during pregnancy, those with a discrepancy between fetal size and onset of pregnancy, and those who, by history, clinical evaluation, or a prior ultrasound, are suspected of carrying a defective fetus.

Possible Side Effects

Now two new studies have cast doubt on the safety of the practice. The first, published by a group of Australian researchers in the British medical journal *The Lancet*, found that frequent exposure to ultrasound may influence fetal growth. The team, headed by John Newnham, an obstetrician at King Edward Memorial Hospital in Perth, Australia, discovered that pregnant women who submitted to frequent ultrasound tests were more likely to deliver babies with a slight but statistically significant drop in birthweight, a primary indicator of health in newborns. The findings suggested that five or more ultrasound

PHOTO: KEVIN BEEBE/CUSTOM MEDICAL

tests between 18 and 38 weeks of gestation, compared to a single test at 18 weeks, increased the proportion of smaller babies by about one-third.

The second study, published in the *Canadian Medical Association Journal*, found that children with delayed speech are about twice as likely as those without delayed speech to have been exposed to prenatal ultrasound. The researchers, headed by James Campbell of the University of Calgary, concluded that "if there is no obvious clinical indication for diagnostic in-utero ultrasonography, physicians might be wise to caution their patients about the vulnerability of the fetus to [such] noxious agents."

Researchers are generally at a loss to explain how ultrasound might cause problems of this nature. The technique, which has been used since the 1970s, is relatively noninvasive in that it builds a near-simultaneous moving picture of the fetus by passing high-frequency sound waves, inaudible to the human ear, into the woman's uterus. The reflected echoes are then detected by a computer and converted into a series of images.

The only direct evidence of adverse effects comes from recent studies indicating that intense ultrasonic energy can alter cells by inducing the growth of tiny gas pockets or bubbles contained in all liquids. Lab studies show that when the bubbles reach "resonance size," they expand and contract and can even implode, releasing mechanical forces and heat intense enough to alter the surrounding matter. Indeed, animal studies have revealed a number of biological effects following intense ultrasound exposure, including lower immune response, a reduced ability for cells to reproduce, even cell death.

There is no evidence that bubble growth occurs during the clinical use of ultrasound in the diagnostic range, and no specific human injury can be attributed to prenatal ultrasound exposure, says Mel Stratmeyer of the Food and Drug Administration's Office of Science and Technology. Still, he says, no one can say that such imaging entails absolutely no risk. —*NIRA WORCMAN*

One novel mine-hunting device takes advantage of the fact that loud sounds cause the ground to vibrate more rapidly wherever a dense object is buried just below the surface. This image, based on the data collected by the system's motion detectors, identifies a mine (in yellow) by the shape of the area with the highest ratio of surface vibration to sound pressure (see number scale).

Detecting Forgotten Land Mines

War leaves many awful legacies, but one of the worst is the estimated 85 million land mines lying around the globe. Faced with the horrifying statistic that 18,000 people—mostly civilians—are killed or injured by land mines every year, experts are scrambling to develop improved techniques for finding old mines.

Mines have proven difficult to locate mainly because of their sheer numbers; they're so inexpensive and easy to build that military leaders of even small countries can afford to bury them by the thousands in a typical battlefield. And while metal detectors can be used to find older mines made from metal, new models made from ceramics and plastic are invisible to such devices.

One new instrument being designed by the U.S. Army to hunt down these insidious weapons is an infrared device known as the Airborne Standoff Minefield Detection System (ASTAMIDS). The system would fly high above the battlefield aboard a robot aircraft and carry an infrared sensor to register the amount of heat coming from objects located in various parts of the battlefield.

The infrared sensor would not necessarily be able to distinguish between an individual land mine and a like-sized rock buried at a typical mine depth, because the computer display of both infrared images would look the same. But that's not a problem when looking for minefields, says Charles Digney, deputy manager for mines and demolition for the Army. A field containing many mines, all buried a few inches beneath the surface, would display a distinctive pattern of identical hot spots, whereas a field with rocks of various sizes buried at different depths would display a random pattern. Still, while ASTAMIDS can be used to identify the general boundaries of a minefield, it would not be efficient at pinpointing individual mines.

Alan Jacobs, a professor of nuclear engineering sciences at the University of Florida, is pursuing a potentially more effective approach for the Army. Jacob's system searches for mines by firing x-rays into the ground. While x-rays zip right into the soil, they are scattered by dense objects buried below. A computer then analyzes the reflected x-rays to detect objects shaped like mines.

The Army's specifications call for

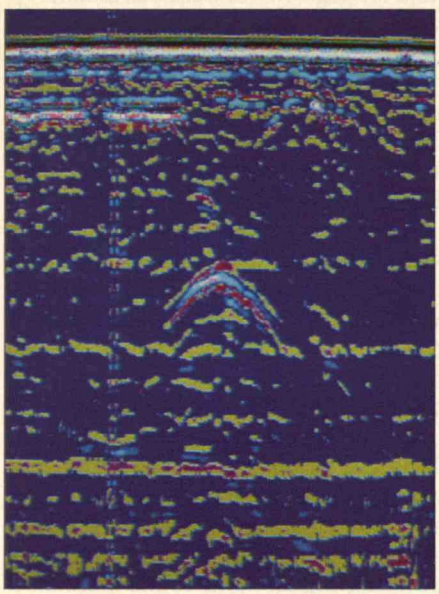
DIAGRAM: UNIVERSITY OF MISSISSIPPI

mounting the machine on the front of a truck. Geared for clearing a path for troops through a minefield, the machine would make 3-meter-wide sweeps through a field at the rate of 5 miles per hour. A demolition team would then detonate the detected mines.

Sound might also be used to locate individual mines, according to Charles Don, a physicist at Monash University in Australia. In a series of experiments, Don used a loudspeaker to aim pulses of low-frequency sound into soil in which simulated mines had been buried. On either side of the loudspeaker two microphones registered sounds reflected back upward. Don discovered that an object buried beneath the surface reflected sounds a split-second after echoes produced from the surface. He then used a computer to analyze the delayed sound wave and flag any mine-shaped objects.

Another acoustic approach comes from James Sabatier, a physicist at the

A detection unit designed for the Army produces color-coded x-ray images of a 10-meter-wide by 4-meter-deep cross section of a field (sand and soil are in blue and solid materials are in yellow and red). A land mine, such as the one in the middle of the image, can be identified by its density and tell-tale parabolic shape.



PUZZLE CORNER

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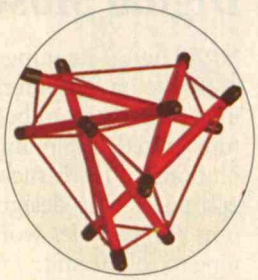

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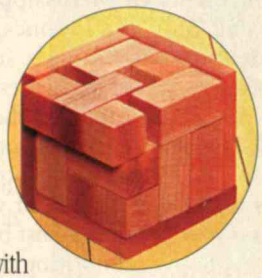

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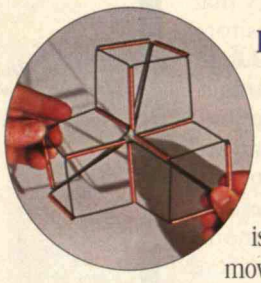

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PHOTO: GEOPHYSICAL SURVEY SYSTEMS, INC.

University of Mississippi. Rather than using only single tones, he is experimenting with sounds such as that of beating helicopter blades, which would be easier to produce in the field. Sabatier discovered that the ground vibrates differently from such powerful sound waves when objects of various shapes and sizes are buried just beneath the surface. So by monitoring the surface with motion sensors and analyzing the vibrations they detect, he is able to identify patterns typically produced by mines.

Peter Blagden, a de-mining expert at the United Nations, points out that last year, while some 84,000 mines were identified and removed using conventional metal-detection techniques, another 2 million mines were added to the already vast store. Thus, even if mine-detection capabilities expand 50-fold by the end of the decade, that would only stem the rise in the number of implanted mines. To begin reducing the number of mines, he says, we must double that capability by 2005 and then double it again by 2010.

Research on anti-mine technologies is being financed by a number of governments, including the United Kingdom's Ministry of Defense and Sweden's National Defense Research Agency. The main challenge, Blagden says, is to achieve detection accuracy in a variety of soil conditions. For example, watery terrain scatters x-rays, rendering systems that use this technique ineffective. In fact, no one sensor will likely be able to find every mine under every condition.

Meanwhile, in addition to adopting an export moratorium on land mines through 1996, the United States has asked for stricter controls in the international protocol governing their use. Such controls would include requiring certain mines to be self-deactivating after a period of time. Part of the 1980 Conventional Weapons Convention, the protocol went into effect in 1983, though it has never been ratified by the U.S. Senate. The protocol is scheduled to be reviewed during an international conference called for next year under the treaty's provisions. —*VINCENT KIERNAN*

Digital Museums

Digital imaging technology—the use of computers to encode visual images so they can be stored, displayed, transmitted, and manipulated—has revolutionized fields such as radiology and computer-chip design. Now art museums and galleries worldwide are beginning to follow suit.

Early in 1995, the National Gallery of Art in Washington, D.C., plans to unveil a so-called Micro Gallery that will allow visitors to browse through digital reproductions of the nation's eminent art collection on any of 17 high-resolution color monitors, and to retrieve works by subject, artist, date, or place of origin. Users of home and office computers equipped with drives to read CD-ROM disks can already pursue a similar opportunity by exploring CD-ROMs of works from the Frick Collection in New York and London's National Gallery. The CD-ROM from the London National Gallery, which includes 2,000 high-quality digitized masterpieces from Rembrandt to Raphael, costs less than $100.

Several companies, including Kodak, Microsoft, and Digital Collections (based in Berkeley, Calif.), have begun amassing and digitally encoding images in anticipation of a considerable trade in CD-ROMs of museum art collections or of "super exhibits" that cull the works of particular artists, wherever those works may reside. As ownership of so-called "multimedia" computers rises into the millions, some entrepreneurs hope to eventually sell digital images of artwork on the information superhighway. Others anticipate the time when instead of mounting paintings or posters on their walls at home, people will hang flat-panel computer screens that display digital art.

One new firm founded by Microsoft CEO Bill Gates, Seattle-based Continuum Productions, has already made agreements with dozens of art museums and other institutions to license and distribute art and photography from their collections in digital form. Continuum expects to release consumer products such as collections of images on CD-ROM disks sometime next year.

Microsoft markets a CD-ROM containing 2,000 digitized masterpieces from London's National Gallery. Viewers use on-screen buttons and icons to navigate the database and obtain additional information about a given work.

Despite such moves, efforts to acquire digital rights to museum collections have met with resistance from some curators, who fear that if images from their institutions become ubiquitous, visitors will be less inclined to travel from all over the world to pay to see the originals.

Janice Sarkow, curator at the Boston Museum of Fine Arts, says that her museum has been bombarded with solicitations from online encyclopedias, advertisers, and CD-ROM vendors to purchase digital rights to the museum's

PHOTO: MICROSOFT

holdings. The requests put Sarkow in an uncomfortable position. Her museum, the oldest in the United States, was founded in 1870 to open up the world of art to the public. But she must now worry about too wide a dissemination of her institution's images.

Museums must be careful "not to relinquish open-ended rights to their collections," Sarkow maintains. If they grant such rights, museums would not only lose profits from unspecified future uses of the images, they would also lose control over what those uses would be. For instance, the images could be incorporated into advertising, which would lessen their value and appeal as museum pieces. "We feel strongly that we are preserving a legacy," she says.

Numerous working groups have begun to address the need for standards to guide the new trade in digital images. One such meeting, funded by Kodak, was held last spring at the Eastman House, a photography museum in Rochester, N.Y. It brought together copyright lawyers as well as individuals representing both museums and firms like Continuum Productions. No clear guidelines have emerged, but participants are trying to craft industry-wide contracts stipulating limited rather than open-ended use of digital artwork, quality standards to protect the integrity and value of the work, and security measures such as incorporating identifying symbols on the works to help guard against unauthorized copying. In September, the International Council of Museums and the Museum Computer Network held their annual meetings consecutively in Washington, D.C., to devote a major portion of their time to such issues.

Katherine Jones Garmil, a director of the Museum Computer Network and a curator at Harvard University's Peabody Museum, sees both sides of the debate. "Exciting possibilities exist for allowing much wider access to art through digital images, Garmil says. "Museums just have to be careful not to simply sell their cultural heritage to the highest bidder."

—*Seth Shulman*

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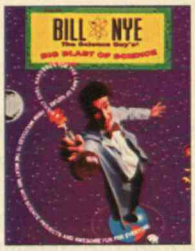

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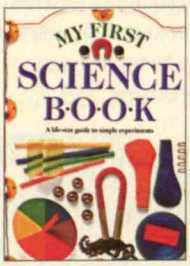

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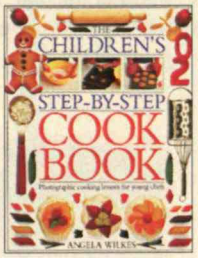

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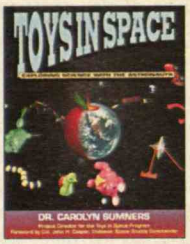

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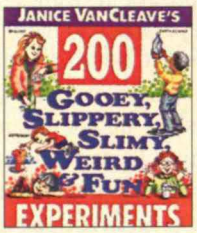

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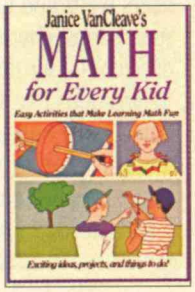

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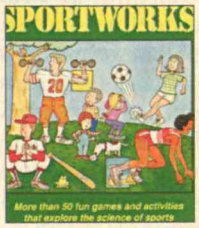

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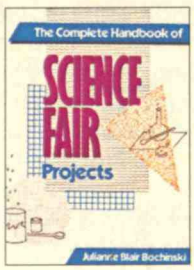

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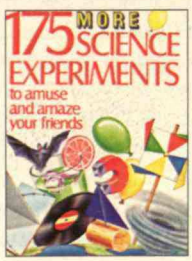

A sequel to the popular *175 Science Experiments*, this book brings further enjoyment to curious kids. Within four main sections—Sound, Electricity, Simple Chemistry, and Weather—it provides a lively menu of experiments, tricks, and things to make.

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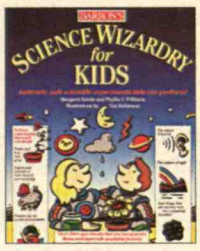

More than 200 authentic, safe experiments that use everyday, inexpensive materials. Kids will get to know the thrill of discovery by looking at their immediate world: making toy boats, brewing sun tea, growing violets, collecting rocks. Includes step-by-step instructions and glossary.

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Edited by Roger E. Axtell

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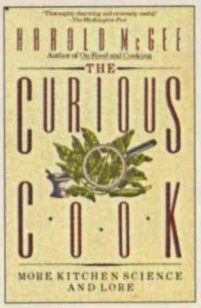
by Harold McGee



How can you keep the green in guacamole and pesto sauce? What's the best way to make fruit ices? Packed with fascinating scientific lore, *The Curious Cook* answers these questions and more to help the home cook make use of scientific discoveries about food.

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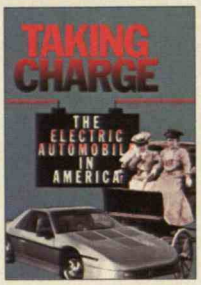
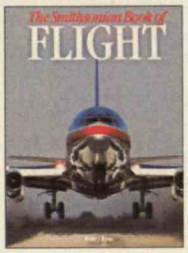


Discover the history and future promise of the electric car in America. This book revisits the race between electric and gas-powered cars in all its aspects, including the little known collaboration of Henry Ford and Thomas Edison. Schiffer suggests that for Americans it may be time for the fabled victory of the tortoise over the hare. *Hardcover, 224 pages, $24.00*

New! The Smithsonian Book of Flight

by Walter J. Boyne



The former director of the Air & Space Museum has composed this beautifully illustrated history of flight. It chronicles the rapid evolution of aviation technology, and focuses on the meaning of flight for the human spirit. A beautifully illustrated single-volume history.

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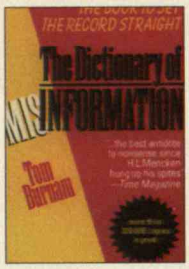

A remarkable book that contains enough information to help you win bets the rest of your life: London's Big Ben is neither a clock nor a tower, scores of people had flown nonstop across the Atlantic before Lindbergh, and no witches were burned at Salem.

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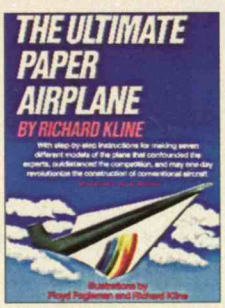

More than just a toy, the Kline-Fogleman airfoil earned its inventors two patents and was tested by NASA. Here is the story of its creation, along with the secrets behind its unmatched performance. Plus, instructions and patterns for making seven different models.

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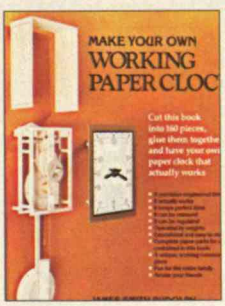

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The New Alchemy

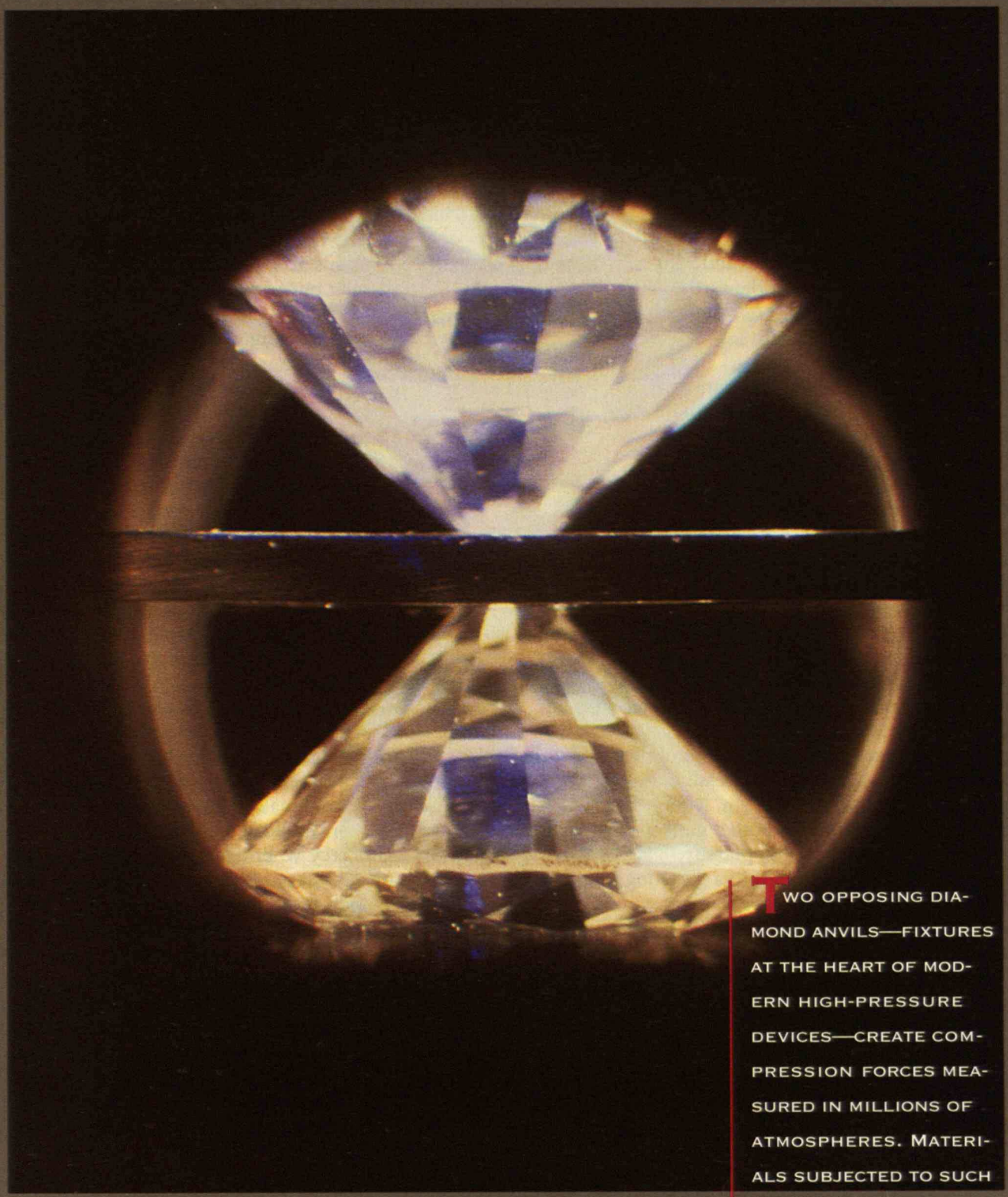
By compressing ordinary compounds under millions of atmospheres of pressure, scientists are creating exotic new materials and discovering the nature of the earth's deep interior.

The physical pressures most of us experience every day are relatively modest. The column of air that extends more than 30 miles above the earth's surface exerts a force on everyone and everything of about 14.5 pounds per square inch—defined as one atmosphere or "bar" of pressure. Most people apply even less than that to a floor when standing or to a chair when seated.

By comparison, the forces created by scientists who study pressure can be staggering. With today's technology, they can observe the effects of more than one million atmospheres, or one megabar—approximately the pressure exerted by a stone monument more than 2,000 miles tall.

Researchers are exploring these extremes because pressure can transform matter in remarkable ways, rivaling any changes observed over the centuries by scientists who have exploited extreme temperature to create new materials and phenomena. Under intense pressure, atoms are squeezed

By Robert M. Hazen



TWO OPPOSING DIAMOND ANVILS—FIXTURES AT THE HEART OF MODERN HIGH-PRESSURE DEVICES—CREATE COMPRESSION FORCES MEASURED IN MILLIONS OF ATMOSPHERES. MATERIALS SUBJECTED TO SUCH PRESSURES TRANSFORM INTO NOVEL FORMS WITH UNUSUAL PROPERTIES.

PHOTOGRAPH: H.K.MAO

together so tightly that their electrons form new bonds or leave their atomic homes, and the relatively open arrangements of atoms found in common materials collapse into dense new forms. Lumps of coal transform into precious gems, common gases change into dense transparent metals, and ordinary compounds turn into superhard abrasives. And high pressure holds promise for creating many other new materials with undreamed of properties as well as for providing a glimpse of the materials and compression processes deep inside the earth.

Under intense pressure, atoms are squeezed together so tightly that their electrons form new bonds or leave their atomic orbits. Most materials then collapse into dense new forms.

The Lure of Diamonds

The high-pressure adventure began with the quest to make diamonds. Humans prized diamonds for thousands of years without knowing what they were or how they came to be. All known specimens came from stream beds and gravels in India and Brazil until the epic South African discovery of diamonds in the region's host rock in the 1870s. Amid the ensuing mining frenzy, geologists eagerly scrutinized the distinctive diamond-bearing matrix—a rock they called "kimberlite" after the Kimberley Mine where it was found—to learn more about diamonds' mysterious origins.

No one had ever seen such a deposit before, but geologists soon began to transcribe the earth's awesome testimony. They discovered that diamonds form deep within the earth, where extreme pressure forces carbon atoms into their hard, dense form. Kimberlite, which features olivine, pyroxene, and other minerals that form at extreme depths, proved that pressure has the power to transform everyday matter into a glittering treasure. Could humans duplicate nature's feat?

Scottish chemist James Ballantine Hannay was among the first to try to mimic the earth's deep interior. His heroic and foolhardy attempts entailed filling iron tubes with volatile carbon-rich compounds, sealing both ends, and placing the cylinders in a 6-foot-long furnace at red heat to cause the compounds to explode, creating 2,000 atmospheres of pressure. In a typical experiment, Hannay wrote, the tube "exploded with a great noise, and knocked down the back and one of the ends of the furnace, leaving the whole structure a wreck." Hannay expressed relief that one worker narrowly escaped injury when a tube shattered in a spray of shrapnel, but anxiety was par for the course. "Watching the temperature of the furnace," he noted, "induces a nervous state which is extremely weakening, and when the explosion occurs it sometimes shakes one so severely that sickness supervenes." Dozens of experiments failed, but in 1880 Hannay at last found a few small diamonds in tube residues. The weary researcher celebrated, wrote up his accomplishment, and went on to safer pursuits.

While Hannay's decision to abandon high pressure research at this pinnacle of success may seem odd, later analysis of Hannay's diamonds, preserved in the collections of the British Museum, showed that they were natural, not synthetic; amid their tiny layers of nitrogen atoms were a tell-tale impurity found only in diamonds from the earth's deep interior. Some historians believe that Hannay's diamonds were the frustrated scientist's conscious fraud. Others of a more charitable disposition suggest that Hannay's loyal assistants, fearing for their mentor's safety, planted the diamonds to please the old man and end the dangerous experiments.

More than a dozen of Hannay's contemporaries in Europe and North America tried everything they could think of to achieve diamond-making pressures. But with each failure by another distinguished researcher, the stakes in the diamond-making game rose.

No one was more fascinated by pressure's transforming power than Percy W. Bridgman, the Harvard physicist who some 25 years after Hannay ushered in the modern era of high-pressure research by squeezing just about any material he could lay his hands on. In a half-century of Nobel Prize-winning research Percy Bridgman studied almost 1,000 different substances, yet no problem proved more difficult than changing graphite, the common form of carbon, into diamond.

Bridgman spent his entire career at Harvard, where he rose through the ranks to full professor. His life's research there began with a lucky break. In 1905, while working on his doctoral thesis in optics, a minor explosion shattered a critical piece of glassware. While waiting for the replacement part to be shipped from Europe, Bridgman busied himself by becoming familiar with the high-pressure apparatus in the lab. In the process, he stumbled upon a completely new design for high-pressure experiments.

Bridgman's discovery involved a key modification of the machinery used to generate high pressure. Every

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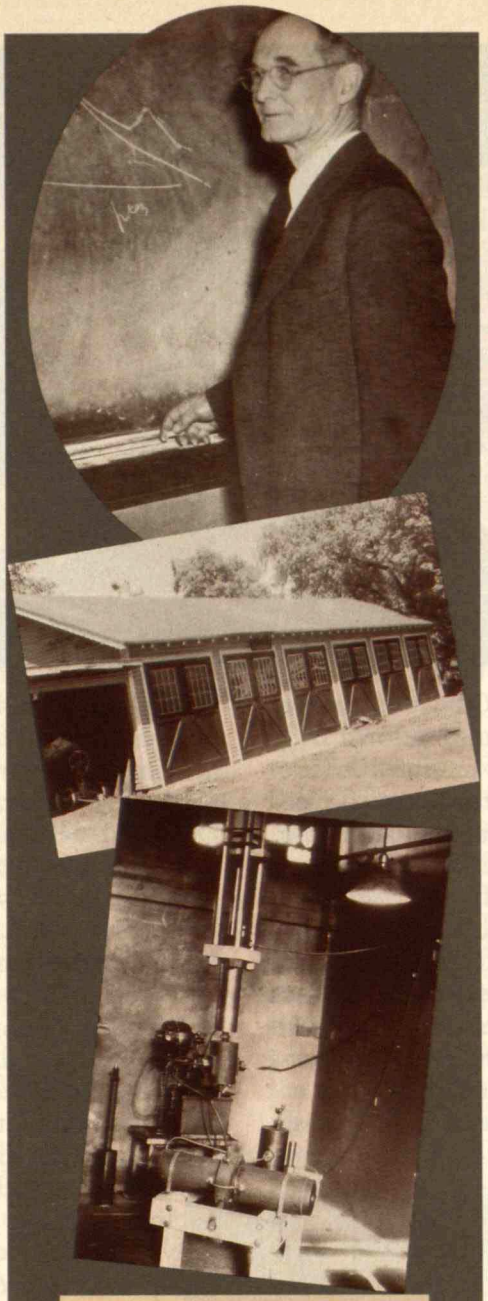
high-pressure system incorporates three components: a press to generate force like a vice; a device to focus that force onto a sample; and the sample to be squeezed. Physicists at the beginning of the twentieth century were unable to confine many samples like liquids at high pressure because they invariably leaked out of any container when pressures rose above about 2,000 atmospheres.

Bridgman devised a method for confining samples inside a ring of a soft, deformable rock called pyrophyllite. As he cranked up the pressure on his sample, the pyrophyllite ring acted as a self-tightening seal. Bridgman knew that pressure is defined as a force acting on an area. His ring-shaped gasket was subjected to the same force as the sample, but it had a smaller area than the sample—and thus was always at a higher pressure. The sample could never leak past the barrier created by the gasket.

"The whole high-pressure field opened up almost at once before me, like a vision of a promised land," he recalled. Within a few years, he could routinely attain more than 20,000 atmospheres—10 times higher than most of his contemporaries could achieve.

Bridgman made headlines in 1910 by squeezing water and identifying five different dense, pressurized forms of "ice" in the process. In 1912 he studied pressure-induced crystals of a dozen common fluids, including alcohols, ether, and acetone. Every experiment was virgin territory, and time after time he discovered new crystalline structures—dense forms of phosphorus, silver nitrate, silver iodide, and dozens of other materials.

For two decades Bridgeman was content to study matter at pressures of up to 20,000 atmospheres, but higher pressures beckoned, and he continually worked to build better equipment. His most elegant device, still used today in many laboratories, was nothing more than a vise with opposed tapered anvils—he called it the "simple squeezer." The first model, invented in 1935, employed anvils of hardened steel with round, flat faces a quarter-inch across. The opposed anvils could be rammed together to apply 50,000 atmospheres on the sample, which was contained by a ring of soft stone. In the late 1930s, Bridgman improved the squeezer by incorporating anvils of tungsten carbide, a much harder material, and he soon achieved pressures in excess of 100,000 atmospheres. Armed with such powers, Bridgman commenced a period of incredible productivity. In fact, during the 1947-48 academic year alone, he experimented with almost one new sample every day, six days a week. Around this time, he turned seriously to the quest for artificial diamonds.



PERCY BRIDGMAN (TOP) REVOLUTIONIZED HIGH-PRESSURE RESEARCH IN HIS MODEST HARVARD LAB (MIDDLE) BY DESIGNING A STONE GASKET TO CONTAIN MATERIALS UNDER PRESSURE, AND TAPERED ANVIL FIXTURES TO CONCENTRATE FORCES APPLIED BY HYDRAULIC PRESSES (BOTTOM).

Bridgman's strategy for making diamonds was simple: squeeze a sample of graphite as hard as possible between two strong surfaces. Unfortunately, even the opposed carbide anvils broke before graphite transformed to diamond, so he reduced the size of the anvil's surface to less than a tenth of an inch across in an effort to concentrate the force per area. Bridgman reported pressures estimated at an incredible 425,000 atmospheres—about 3,000 tons per square inch. Yet graphite not only persisted but bounced right back to its original form when the pressure was released. Bridgman abandoned the effort to make diamond with the wry observation that in graphite he had discovered "nature's best spring."

Bridgman's unsuccessful diamond research demonstrated that pressure alone might be insufficient to make the gems. He and other researchers suspected that sustained high temperatures, perhaps greater

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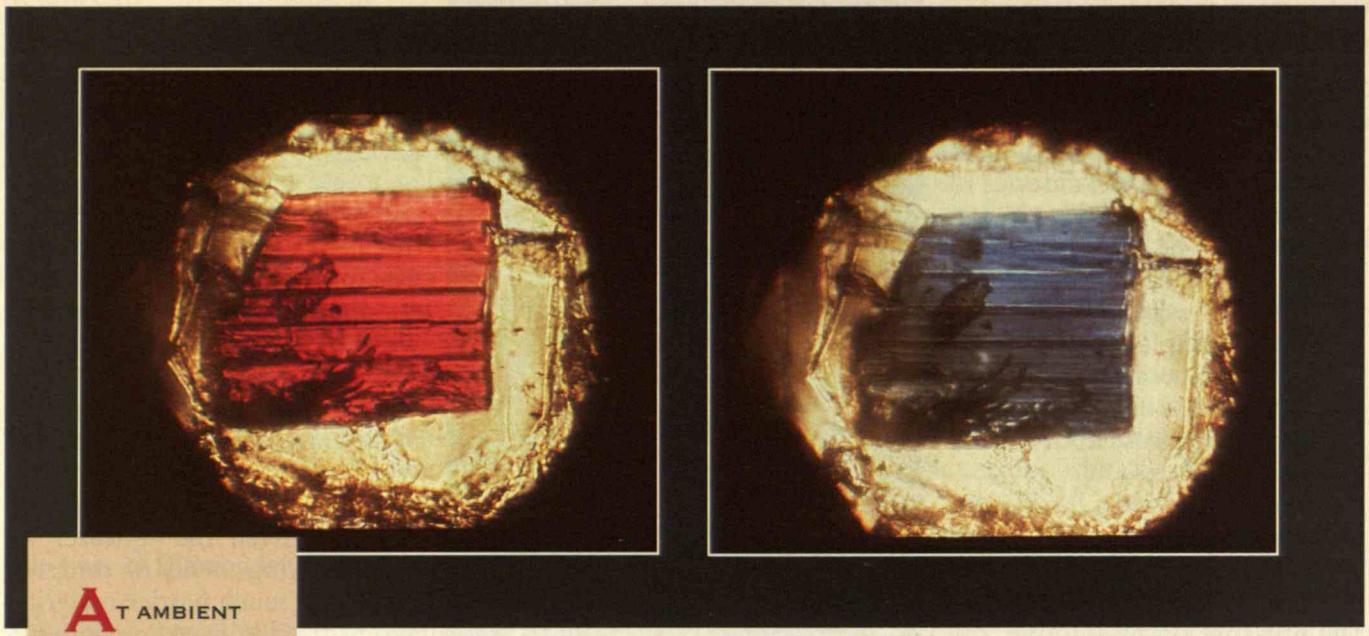


AT AMBIENT PRESSURES, THE IRON-RICH MINERAL GILLESPITE APPEARS RED. BUT AT 20,000 ATMOSPHERES OF PRESSURE, THE MINERAL'S ATOMS ADOPT AN ELECTRONIC CONFIGURATION THAT ABSORBS RED LIGHT AND SCATTERS BLUE.

than 1,000°C—enough to weaken and deform ordinary high-pressure devices—would be required to speed up the transformation. Furthermore, chemists suspected that a compound that could dissolve graphite would also be essential to separate the carbon bonds and enable the atoms to rearrange themselves into a dense diamond matrix.

Surmounting these obstacles took on a new urgency during the Cold War, when a reliable and abundant supply of diamond abrasives would be crucial for shaping the hard metal components of military hardware. General Electric in Schenectady, N.Y., was one of the industrial giants that dedicated itself to developing an industrial diamond-making process. Following the theory that graphite's tenacious bonds had to be broken apart before the carbon molecules could form a diamond matrix, the GE researchers heated graphite to more than 1,500°C with a powerful electric current and mixed it with molten iron. Graphite's molecular bonds were dissociated in the fiery alloy, which was contained within a doughnut-shaped belt of carbide and steel squeezed to only 60,000 atmospheres of pressure before it turned into diamond. Where individual efforts had failed, GE's team approach succeeded in creating the first synthetic diamonds in December of 1954. Less than three years later, the commercial production of superhard abrasives began.

Since then, synthetic diamonds have transformed the ubiquitous industrial processes of cutting, grinding, and polishing. They affect our daily lives by making possible activities as common as swift dental drilling, surgically precise road repair, and one-hour eyeglass lens grinding. Diamond abrasives have also transformed urban architecture by making elegant polished stones widely available for use as interior and exterior surfaces.

Journey to the Center of the Earth

But the diamond-making breakthrough did more than begin a billion-dollar industry. It begat a new generation of high-pressure equipment and demonstrated in dramatic fashion that pressure not only could transform ordinary matter into extraordinary materials, but that this occurs routinely deep within the earth and throughout the universe.

By the 1960s dozens of researchers had joined the high-pressure game, but none did so with more intensity than geophysicists, who saw squeezing rock with high pressure as a way to measure the temperature and composition of the earth's interior. Among the first to take this approach was Russian geologist Sergei Stishov, at the time a graduate student curious to see how ordinary beach sand, which is made of quartz, might react at high pressure. In 1960, using a large press at Moscow's Institute of High-Pressure Physics, Stishov applied more than 100,000 atmospheres to the mineral and created a new material 60 percent denser than quartz.

Shortly after Stishov's announcement, U.S. geologists discovered the same dense mineral in material that had been subjected to the sudden high pressures of impact at Meteor Crater, Ariz. They named it stishovite—an honor that earned Sergei Stishov 20 years of ostracism from jealous superiors at the Institute of High-Pressure Physics.

After Stishov's discovery, earth scientists were eager for devices that could generate even higher pressure. Their

PHOTOS: R.M.HAZEN

goal was to subject samples to pressure greater than 1 million atmospheres, the pressure found deep inside the earth and that to which most of the mass of the universe is subjected in stellar and planetary interiors.

Fortunately, the scientific and technological lure of a million atmospheres—a megabar—drove several scientific teams in the 1960s and 1970s. Following Percy Bridgman's lead, researchers at the University of Chicago and the National Bureau of Standards (NBS) almost simultaneously crafted opposed-anvil devices made of the hardest known material—diamond, which is not only hard but also transparent. Unlike with all previous devices, a researcher could now actually watch samples crystallize and change form and color as they were squeezed between two transparent diamonds.

No one took greater pleasure in this discovery than Alvin Van Valkenburg, who designed the NBS "diamond anvil cell," as it came to be known. He learned to contain samples by placing a thin flat piece of metal with a tiny hole in it between the two diamond anvils, thus forming a tiny sample chamber about one-hundredth of an inch across. As Van Valkenburg squeezed the diamonds together in a steel device, something like a large nutcracker, he would sit for hours at his microscope, watching with delight as crystals grew and changed. His dramatic photographs of crystallized alcohol—"gincicles," he called them—appeared in newspapers across the country.

The first diamond anvil cells attained close to 300,000 atmospheres. Some argued that the cell could never go much higher—that even diamond would break long before a million atmospheres. But researchers David Mao and Peter Bell in the Geophysical Laboratory at the Carnegie Institution in Washington, D.C., took up the challenge, engineering a pressure cell similar to Van Valkenburg's, but with two key improvements. Mao and Bell provided carbide supports for the diamond anvils, which had a tendency to sink into most steel backings, and designed slightly rounded diamond tips that were less likely to chip around the edges.

To measure accurately the high pressures obtained by their improved device, Mao and Bell squeezed a fine powder of crushed ruby between the two diamond anvils. Rubies fluoresce a brilliant red color, and the exact wavelength of that red fluorescence shifts steadily with pressure, making them ideal for calibrating high pressures. In 1975 Mao and Bell compressed a tiny ruby sample and observed the largest wavelength shift ever recorded—equivalent to more than 1 million atmospheres, or one megabar.

The diamond cell provided geophysicists with their best opportunity to duplicate conditions in the earth's deep interior. Not only does the cell produce the highest sustained pressures—today's improved models with anvil tips less than 50 microns across can reach 5 megabars—but samples in the diamond cell can also be heated with a laser to thousands of degrees, reproducing conditions at the very center of the earth.

Of all the diamond-cell practitioners, none has pursued the task of modeling the planet with more flamboyance than Raymond Jeanloz of the University of California at Berkeley. In a recent experiment, Jeanloz collaborated with doctoral student Elise Knittle in a study of the earth's core-mantle boundary—a zone about 2,000 miles down where iron-rich liquid is believed to contact a silica-rich rock at temperatures of more than 3,000°C and pressures greater than a megabar.

To duplicate that region, Knittle and Jeanloz simply loaded their diamond cell with a tiny piece of iron foil surrounded by powdered magnesium silicate perovskite, a mineral thought to form most of the lower mantle. They raised the pressure to almost a megabar and zapped the mixed sample with a laser beam powerful enough to melt the iron. Under these conditions the molten iron and perovskite

BECAUSE OF THEIR TRANSPARENCY, DIAMOND ANVIL FIXTURES ENABLED RESEARCHERS TO OBSERVE PHENOMENA SUCH AS THE PRESSURE-INDUCED GROWTH OF ALCOHOL CRYSTALS, OR "GINCICLES."

PHOTO: ALVIN VAN VALKENBURG

By taking a tiny piece of iron foil, dusting it with powdered minerals from the earth's mantle, melting the sample, and subjecting it to 1 million atmospheres of pressure, researchers can simulate the topography of the earth's core-mantle boundary.

underwent an unexpected rapid chemical reaction, creating a zone of new iron-rich oxides and silicates.

In a lead article in a March 1991 issue of *Science* magazine, they predicted a core-mantle boundary with a dramatic reaction zone and astonishing topography: mountains of iron-rich minerals perhaps 100 miles tall floating on the liquid core. Such irregularities, they noted, could explain several of the earth's most curious features, including hot plumes of rock beneath the Hawaiian Islands and the puzzling surface variations in the earth's magnetic field.

Knittle and Jeanloz had measured a pressurized sample no larger than a fly speck yet had extrapolated to explain phenomena on a global scale. Some readers thought the Berkeley researchers' conclusions were too bold and sweeping, yet in one short scientific article they had transformed the way we imagine the earth's dynamic deep interior.

In 1989 Jeanloz and graduate student Charles Meade devised a simple diamond-cell experiment to duplicate puzzling earthquakes that originate hundreds of miles below the earth's surface. Geologists tell us that rock behaves a lot like taffy: at warm temperatures it will soften and bend, a phenomenon that allows mantle rock and crustal plates to flow. But when cooled, rock will become brittle and break with a snap when stressed, which can cause earthquakes. Given this premise, tremors should logically occur in cool rocks near the surface. But seismologists, who can pinpoint the exact depth of any earthquake, find powerful "deep focus" earthquakes at depths of 400 miles, well below the region of any conventional mechanism for rock breaking.

To explore how a violent deep earthquake could occur, Meade and Jeanloz mimicked the phenomenon by subjecting minerals to mantle pressures and temperatures, attaching a sensitive microphone to their diamond cell to listen for any telltale sounds as they squeezed tiny samples of minerals thought to occur at those mantle depths. Nothing unusual happened with dry minerals, but when the researchers squeezed and heated serpentine, a common mineral with water locked in its crystal structure, they were amazed to hear a series of audible "pops"—which they theorized were miniature earthquakes. After repeatedly observing the effect, they realized that the sound occurred as water escaped from the sample, and theorized that serpentine could be the culprit in deep-focus earthquakes.

These experiments led to the remarkable conclusion that the oceans may be continuously feeding water into the earth's mantle. The earth's oceans seem forever isolated from the deep interior, but Meade and Jeanloz's theory suggests that ocean water reacts with hot volcanic rocks to form hydrous minerals such as serpentine at mid-ocean ridges where new crustal plates are being created, and that some of those rocks are eventually carried back down into the mantle by the dynamic processes of plate tectonics.

Thus the oceans may represent only one part of an immense, dynamic system that includes slabs of water-rich rocks extending deep into the mantle of our planet. During some 4.5 billion years of earth's history, the water of the oceans could have recycled four times over, and several oceans worth of water could be locked in the present mantle. This astonishing proposition, which will drive the research of many earth scientists for years to come, is made all the more remarkable by the evidence—the behavior of a tiny sample squeezed between two diamonds.

A Brave New World of Materials

Of the hundreds of thousands of known materials, perhaps a thousand have been studied at modest pressures of a few thousand atmospheres, and only about 30 elements and simple compounds have been subjected to a megabar of pressure or more.

Of these materials, most have undergone several transitions to several new forms as pressure was increased to a million atmospheres. Thus, we might easily triple or quadruple the entire range of known materials simply by applying such pressures to them. Many of the resulting new materials, including stishovite, persist at room conditions and therefore might be manufactured in quantity. For example, General Electric scientists discovered a new high-pressure form of boron nitride—an abrasive with a diamond-like structure that has proved even tougher than diamond for machining certain metals—that remains stable at room pressure.

Still, most high-pressure substances revert to their low-pressure forms when removed from the diamond

cell. Even so, they may still provide insight into novel atomic structures that might be obtained at room pressure with appropriate chemical substitutions. In 1987, for example, physicist Paul Chu and his colleagues at the University of Houston detected greatly enhanced superconducting properties in a pressurized compound containing copper, barium, lanthanum, and oxygen. Unfortunately, without pressure the compound sprang back to its original form and lost its superconductivity. But by substituting the smaller element yttrium for lanthanum, the team created a material that mimicked the pressurized material's properties at room pressure. The result was the now-famous high-temperature superconductor that works at liquid-nitrogen temperature.

Of all known materials, none is more intriguing to materials scientists than hydrogen, the first element in the periodic table. Physicists who have analyzed the theoretical behavior of hydrogen at extreme conditions suggest that if you squeeze hydrogen gas hard enough—to perhaps 2 or 3 megabars—it will become a solid metal.

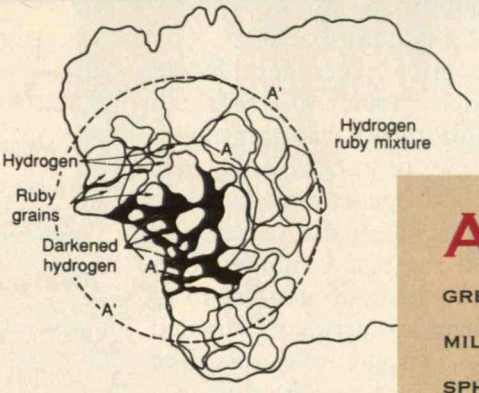
Some theorists who model hydrogen's electronic behavior calculate that in metallic form, hydrogen will be a superconductor—a material that transmits electrical energy with absolutely no loss—at room temperature. In an energy-hungry world, where every power cable and wire eats a bit of any passing current, superconductors could save us billions of dollars.

Others predict that metallic hydrogen will represent the most concentrated form of chemical energy imaginable. As a rocket fuel, it might store hundreds of times more thrust per pound than any other material. As an explosive, it could be 35 times more destructive than TNT.

Yet in spite of these potential applications, most scientists tackle high-pressure hydrogen research for other reasons. For physicists, hydrogen experiments provide excellent tests of theoretical models of matter, because the hydrogen atom has only one electron and thus is simpler than other elements to describe mathematically. And astronomers know that the giant planets of our solar system—Jupiter, Saturn, Uranus, and Neptune—are made almost entirely of hydrogen. If the element does become a metal at a few megabars—just a small fraction of these planets' interior pressures—then metallic hydrogen is surely the most abundant solid in the universe. Without first understanding its true nature, scientists cannot accurately model the dynamics of large planets and the birth of stars.

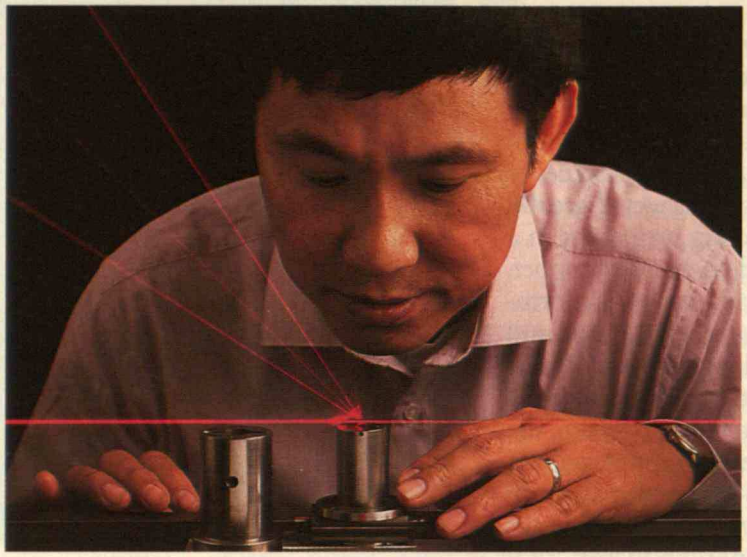
But the goal of creating metallic hydrogen, a quest that has driven a small army of researchers for the past 20 years, is strewn with obstacles. After confining a minute hydrogen sample no larger than a speck of dust between two diamonds, it must be gradually squeezed to near record pressures. Fortunately, loading a cell with liquefied hydrogen is now routine, as is achieving the 50,000 atmospheres required to solidify hydrogen to colorless, ice-like crystals. But hydrogen molecules are so small that when subjected to higher pressure they act like atomic wedges and exploit the slightest imperfection in a diamond anvil's surface. In fact, most experiments fail at less than a megabar with shattered diamonds.

If one is lucky enough to push hydrogen above 1.5 megabars, it is possible to detect the change. Below 1.5 megabars, solid hydrogen consists of a regular arrangement of dumbbell-shaped H_2 molecules, which are free to rotate in any orientation. But experiments that measure the way pressur-



AT PRESSURES GREATER THAN 2.5 MILLION ATMOSPHERES (OR MEGABARS), DARK VEINS APPEAR IN THIS SAMPLE OF HYDROGEN MIXED WITH RUBY, INDICATING THAT HYDROGEN'S MOLECULAR BONDS HAVE BROKEN APART AND THAT INDIVIDUAL ATOMS HAVE REARRANGED THEMSELVES INTO A LIGHT-ABSORBING METALLIC FORM.

PHOTO: GEOPHYSICAL LABORATORY, CARNEGIE INSTITUTION OF WASHINGTON



ized hydrogen scatters light reveal that the H_2 molecules adopt a fixed orientation above 1.5 megabars. Moreover, near this pressure the sample increasingly absorbs infrared light. This behavior leads some scientists to speculate that the molecules have begun to break apart and rearrange themselves in a new orientation that could be metallic in nature.

Only one team of researchers, David Mao and Russell Hemley of Carnegie's Geophysical Laboratory, has gone much higher. In a series of experiments, they compressed a hydrogen sample at pressures higher than 2 megabars. As Mao and Hemley turned the screw of their diamond-anvil cell, the hydrogen began to absorb visible light at a pressure estimated at more than 2.5 megabars—a possible sign of another form of metallization.

They repeated the experiment with new samples and new cells and then published the results with a dramatic color photograph of dark hydrogen. The story of the unusual high-pressure behavior made headlines, but left many intriguing questions unanswered. What is the nature of the odd 1.5-megabar form of hydrogen? Does the observed darkening above 2.5 megabars correspond to the metallization long predicted by physicists, or is it some other exotic material? Will scientists be able to stabilize the metal at room pressure?

Meanwhile, research teams in a score of countries continue the quest for ever higher pressures and new materials with novel properties. Can we achieve 35 megabars to match the interior pressure of Saturn, or 100 megabars to duplicate conditions deep inside Jupiter? To achieve these forces, some researchers envision elaborate two-stage devices in which a compact diamond-anvil cell, about the size of a stack of half a dozen quarters, is itself encased in a larger pressure device and squeezed in a giant press.

As pressures continue to rise with the implementation of such techniques, many new substances not found at low pressure will likely be discovered. In recent months, for example, earth scientists at the Carnegie Institution in Washington, D.C., have described unique high-pressure crystals containing bonds between helium (normally an inert gas) and other elements such as nitrogen or hydrogen that may compose much of the interiors of the giant planets. They have compressed mixtures of hydrogen and other substances to discover new crystalline compounds of water and hydrogen molecules, as well as a dense form of iron hydride that may provide a repository for hydrogen in the earth's core. Elsewhere, researchers in Grenoble, France, have pressurized buckyballs—hollow, spherical molecules with 60 carbon atoms—into a new diamond-like material, while workers in Japan have documented a similar transformation in ordinary graphite. And scientists at Arizona State University used high pressure to create the first stable form of fully nitrided glass, a superhard material that substitutes nitrogen for the oxygen usually present in glass compounds.

Scientists searching for novel high-pressure materials are also likely to encounter unexpected physical phenomena. Numerous researchers around the world, for example, are documenting "pressure-induced amorphization," which occurs in a remarkable range of materials, including molecular solids, metallic alloys, semiconductors, and ordinary beach sand. Not only does pressure-induced amorphization hold promise as a possible manufacturing strategy, but it may also play a signficant role in geological processes associated with earthquakes and plate tectonics.

The rapid pace of such discoveries promises that we have only just begun to probe the possibilities of the high-pressure realm. ■

DAVID MAO IS A MEMBER OF THE TEAM THAT FIRST CRACKED THE 1-MEGABAR BARRIER AND OBSERVED METALLIC TRANSITIONS IN HYDROGEN. HIS LAB HAS CREATED SEVERAL NEW HYDROGEN-BEARING CRYSTALS USING DEVICES PRODUCING SUSTAINED PRESSURES OF MORE THAN 5 MEGABARS.

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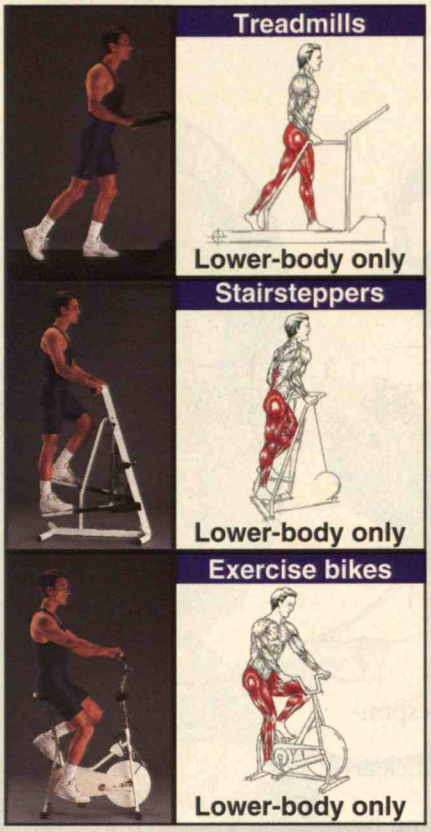

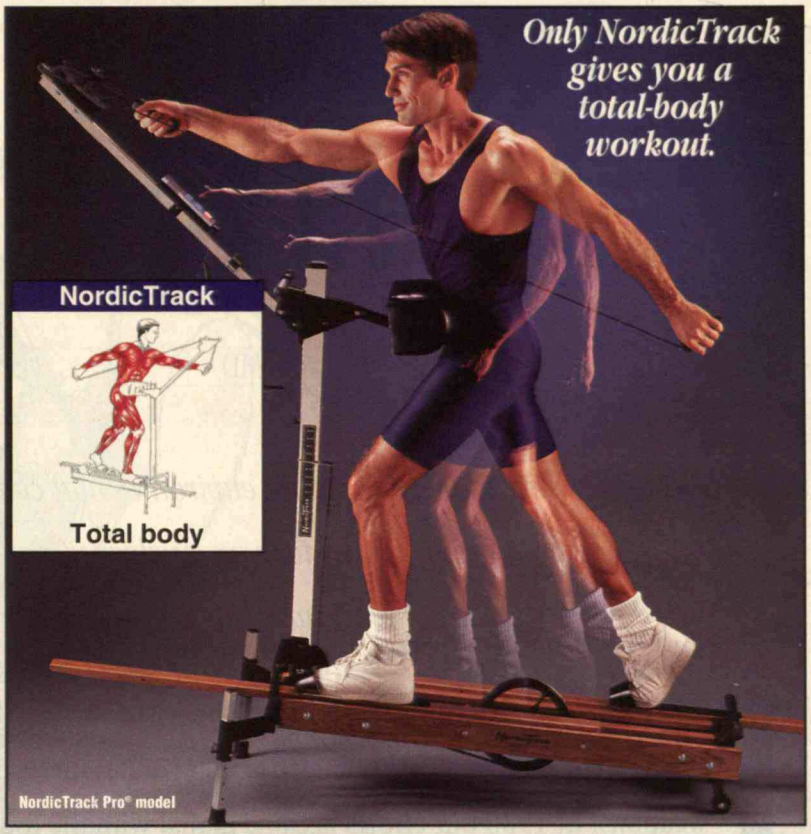

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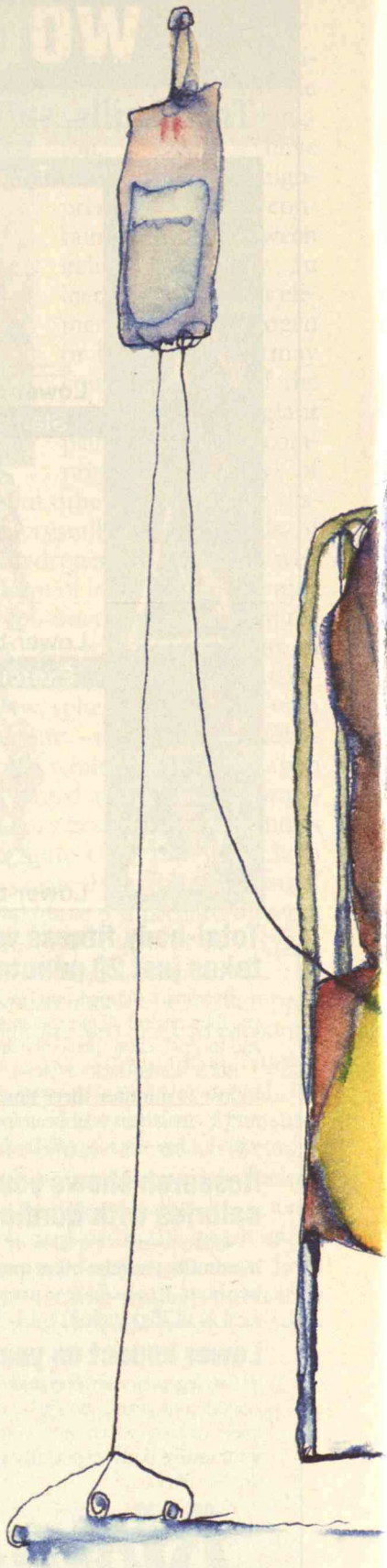
By Eric Chivian, MD

Physicians are addressing global environmental change for the same reason they took on nuclear war: it is basically a human-health issue.

In 1961 Boston-area physicians formed Physicians for Social Responsibility to help increase public understanding of the effects of nuclear weapons. In 1980 our efforts became global with the founding by Bernard Lown, James Muller, Herbert Abrams, and myself of International Physicians for the Prevention of Nuclear War, which five years later won the Nobel Peace Prize.

You might ask why physicians became involved with an issue like nuclear war at all, much less chose to be central figures. Wasn't this the province of physicists, politicians, and the military?

We recognized that the consequences of nuclear war were ultimately those of human health and survival, and we were concerned that because these consequences were often poorly understood, greatly underestimated, and outright denied, even at the highest levels of government, a nuclear war was more likely to occur. We also believed that physicians, by virtue of their training and experience, had the ability to translate the abstract,



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MEDICAL REPORT
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complex science of nuclear weapons into the concrete, personal terms of human health, thereby making nuclear war more real and comprehensible for the average person.

Society now faces a similar threat from global environmental degradation, and there is a similar lack of understanding of, and curious silence about, its consequences for human beings. Once again, physicians have a special role to play.

As with nuclear war, global environmental change is ultimately a matter of human health, which is totally dependent on the health of the environment. Yet this basic fact is often ignored in environmental discourse, and physicians and other public-health experts are generally not part of environmental-policy discussions.

At the United Nations Earth Summit in Rio de Janeiro in 1992, for example, the excellent report by the World Health Organization, *Our Planet, Our Health*, received almost no attention. And the several-hundred-page final document from the summit, *Agenda 21*, contained only a single, 20-page, highly superficial chapter on health. When I identified myself as a physician at the summit's meetings, I was frequently asked even by senior environmentalists, what could possibly have brought a physician to an environmental conference.

In the United States, the health effects of environmental change get the same inattention. Discussions of issues such as creating an energy tax or logging in forests of the Pacific Northwest rarely mention the implications for human health. Moreover, there is little support for training or research on environmental health issues. The National Institute of Environmental Health Sciences, one of the principal federal agencies responsible for such training and research, ranked last in funding among the 23 institutes of the National Institutes of Health for the past decade. Nor is it faring any better now, having received the smallest increase for FY 1994, behind the dental institute. Even the National Academy of Sciences in its 1991 report *Policy Implications of Greenhouse Warming*, while reaching major conclusions about health effects, did not include one physician or public-health expert on the panel drafting the report.

A Fundamental Misunderstanding

How can one explain this relative neglect of human health in the environmental debate?

One reason may be the same avoidance and denial that greeted the prospect of nuclear war—it is less frightening to talk about the fate of old-growth forests, wolves, and whales than it is to talk about the threat to ourselves. Another reason, perhaps, is that those who set environmental policy—by and large politicians, lawyers, and economists—have little if any training in medicine and public health, or in science at all, and tend to overlook what they don't understand.

Physicians who do have this training, and who one would expect to introduce a human-health perspective into the environmental debate, are also generally uninformed when it comes to the relationship of the environment to health and disease. Medical students in the United States, on average, receive only six hours of education on environmental and occupational health during four years of medical school, and even less time on global issues such as population growth, climate change, ozone depletion, habitat destruction, and biodiversity loss, all of which are likely to have a much larger impact on human health than any local or regional environmental problem.

But perhaps the most important factor in the neglect of this subject is a fundamental and widespread misunderstanding about humanity's place in nature. Most people still believe that we are somehow separate from the environment—that it is ours to conquer and exploit with impunity. They convince themselves that we can change the atmosphere; pour toxic and radioactive chemicals into rivers, oceans, and the soil; destroy habitats and render countless species extinct, diminishing biological diversity and upsetting delicate ecosystems in the process, without these changes affecting us.

A brief examination of the potential human-health consequences of global environmental degradation quickly illustrates the shortsightedness and danger of this widespread belief.

GLOBAL CLIMATE CHANGE resulting from the accumulation of greenhouse gases, for example, is likely to have significant health effects, both direct and indirect. An average global temperature rise of 3-4°C, predicted for the year 2100 by the Intergovernmental Panel on Climate Change, will greatly increase the number of days in the United States with temperatures over 38°C (100°F), with a resulting sharp rise in heat-related mortality. Deaths would occur primarily from heat strokes, heart attacks, and cerebral strokes. The very young, poor, and elderly, as well as those with chronic cardiovascular and respiratory diseases, are most at risk. During the two-week heat wave of July 1993 in the eastern United States, 84 people died in Philadelphia alone as a result of the higher temperatures.

The U.S. Environmental Protection Agency has warned that global warming and changing patterns of

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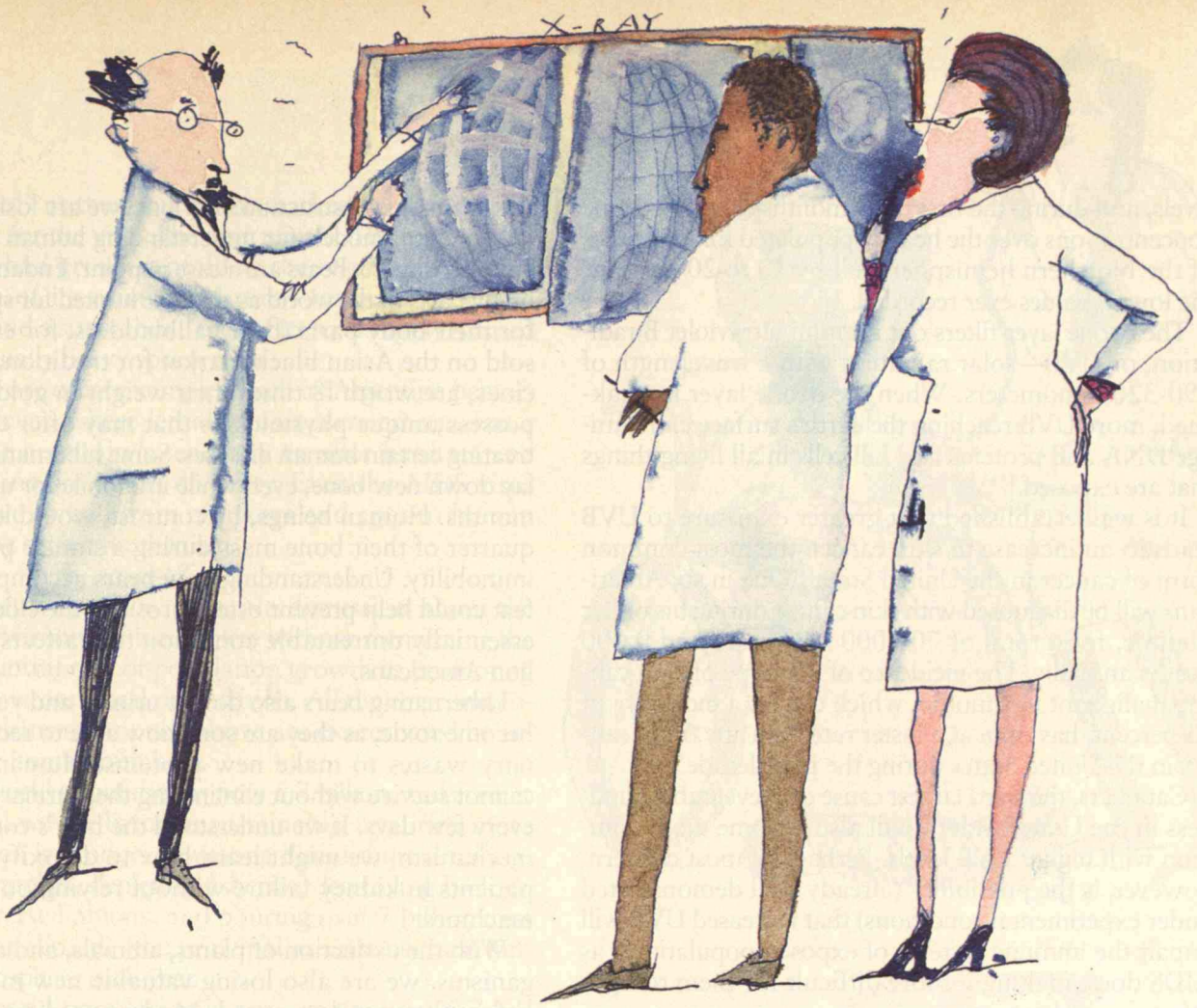


rainfall could also result in the spread of some infectious diseases, as the ranges of the insects carrying infectious agents enlarge to areas that were formerly too cold for them to survive, and as their rates of reproduction rise. We could see in the United States major outbreaks, and possibly epidemics, of dengue fever, some forms of encephalitis, Rocky Mountain spotted fever, Lyme disease, and even malaria and yellow fever.

There are also indications that cholera could once again become a major public-health problem in several parts of the world, including the United States, as a result of global warming. Evidence is mounting that warmer seas and increased carbon-dioxide concentrations in sea water (as a result of growing concentrations in the atmosphere), coupled with the flood of nutrients from sewage and agricultural runoff, favor an overgrowth of marine algae—an ideal medium for the proliferation of the cholera pathogen, *Vibrio cholerae*. Such is thought to have been the mechanism that triggered the cholera epidemic of 1991, which started on the coast of Peru, perhaps from cholera bacteria carried by boats from Bangladesh. The disease spread rapidly through South America, infecting 500,000 people and killing 5,000.

The indirect health consequences of global climate change and ozone depletion, which may act synergistically, could be even more life-threatening than the direct ones.

STRATOSPHERIC OZONE DEPLETION offers the clearest example of how human beings can accidentally damage the global environment. Chlorofluorocarbons, or CFCs, were developed because they were nonflammable, nontoxic, cheap, and extremely nonreactive chemically. No one predicted they could be an environmental hazard, much less that they would catalyze the destruction of ozone molecules in the stratosphere.

Largely because of CFCs, the stratospheric ozone layer has been thinned worldwide—its concentration over the Antarctic has dropped in early spring by as much as 50 percent from baseline

levels, and during the first three months of 1993, ozone concentrations over the heavily populated mid-latitudes of the Northern hemisphere fell by 10 to 20 percent, the lowest values ever recorded.

The ozone layer filters out harmful ultraviolet B radiation, or UVB—solar radiation with a wavelength of 290-320 nanometers. When the ozone layer is weakened, more UVB reaching the earth's surface can damage DNA and proteins and kill cells in all living things that are exposed.

It is well established that greater exposure to UVB leads to an increase in skin cancer, the most common form of cancer in the United States. One in six Americans will be diagnosed with skin cancer during his or her lifetime, for a total of 700,000 new cases and 9,000 deaths annually. The incidence of one type of skin cancer, malignant melanoma, which carries a mortality of 25 percent, has risen at a faster rate than any other cancer in the United States during the past decade.

Cataracts, the third largest cause of preventable blindness in the United States, will also become more common with higher UVB levels. Perhaps of most concern, however, is the possibility (already well demonstrated under experimental conditions) that increased UVB will impair the immune systems of exposed populations, as AIDS does, making it more difficult for them to fight infections and cancers.

The indirect health consequences of global climate change and ozone depletion, which may act synergistically, could be even more life-threatening than the direct ones. These include health effects from drought and flooding, more violent storms, reduced availability of drinking water, and damage to or loss of sensitive flora and fauna worldwide, including some food crops and livestock.

HABITAT DESTRUCTION AND SPECIES EXTINCTION. Very little is known about most species on earth today—about 1.5 million are recorded, but evidence indicates that there may be 100 million or more.

Rainforests are thought to contain the richest variety of species. Composing only about 6 percent of the world's land mass, they contain perhaps 50 percent of the world's species. But human beings are destroying rainforests at a very rapid rate—approximately 150,000 square kilometers are being cut and burned each year (an area the size of Switzerland and the Netherlands combined). The result of this deforestation, ecologist E.O. Wilson and others have estimated, could be the extinction of one-quarter of all species during the next 50 years—the largest extinction since the demise of the dinosaurs some 65 million years ago.

What are some of the human-health implications of this wholesale destruction? For one, we are losing valuable medical models for understanding human physiology and disease. Bears are a case in point. Endangered in many parts of the world as they are hunted for sport and for their body parts (bear gallbladders, for example, sold on the Asian black market for traditional medicines, are worth 18 times their weight in gold), bears possess unique physiologies that may offer clues for treating certain human diseases. Some hibernating bears lay down new bone, even while immobile for up to five months. Human beings, by contrast, would lose one-quarter of their bone mass during a similar period of immobility. Understanding how bears accomplish this feat could help prevent osteoporosis in the elderly—an essentially untreatable condition that affects 25 million Americans.

Hibernating bears also do not urinate and yet do not become toxic, as they are somehow able to recycle urinary wastes to make new proteins. Human beings cannot survive without eliminating their urinary wastes every few days. If we understood the bear's conversion mechanism, we might learn how to detoxify human patients in kidney failure without relying on dialysis machines.

With the extinction of plants, animals, and microorganisms, we are also losing valuable new medicines before they are discovered. Modern medicine would have difficulty doing without quinidine, one of the most important treatments for cardiac arrhythmias; vincristine, one of the most effective agents for combating child leukemia; and erythromycin, one of the best broad-spectrum antibiotics. All are derived from tropical organisms.

But it is not only the tropics where important medicines are found. Aspirin was originally derived from the willow tree, found in temperate zones, and Taxol, the most successful medicine yet discovered for treating ovarian cancer, comes from the Pacific yew tree in old-growth forests of the Pacific Northwest. How many more wonder drugs capable of curing presently incurable infections, cancers, and other illnesses that cause enormous human suffering are being lost forever because of species extinction?

Eliminating species may also upset delicate ecosystem balances between predators and prey and between parasites and hosts that now hold some infectious diseases in check. The dynamics of such relationships are poorly understood, but their disruptions have potentially ominous implications for human beings.

The outbreak of a rapidly fatal pulmonary illness in the American Southwest during the summer of 1993 demonstrates the sensitivity of such equilibria. Not identified before, this infectious disease, caused by a virus from the family known as hanta viruses, seems to have

"emerged" as the result of the marked proliferation of the host for the virus, the deer mouse. The mouse population had grown tenfold as the result of a relative absence of its usual predators—foxes, snakes, and owls—and a superabundance of its food supply (caused by unusually heavy spring rains).

There are other examples, such as Argentine hemorrhagic fever, where lethal viruses have emerged as a result of humanity's tendency to alter habitats and undermine biological diversity. Even the AIDS virus may have spread from monkeys and apes to human beings by such a mechanism.

POPULATION GROWTH. No discussion about the environment is complete without mentioning the central role of population growth in promoting environmental degradation. All the environmental problems mentioned above are exacerbated by increasing human numbers.

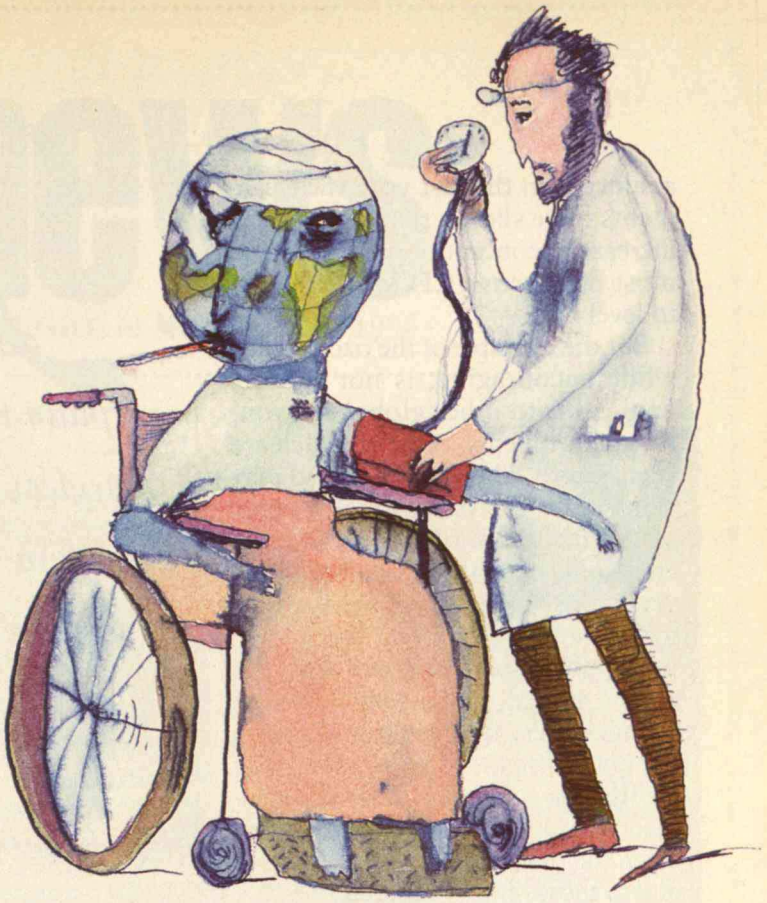
The world population is now 5.7 billion, and even at this level we are living unsustainably, requiring more grain than is produced, wasting diminishing drinking-water supplies, depleting fisheries, destroying biologically diverse habitats, and pouring over 7 billion tons of carbon dioxide (the principal greenhouse gas) into the atmosphere each year.

But world population is not remaining at 5.7 billion—it is growing by more than 90 million a year, a figure equal to the population of Mexico, and the United Nations estimates that unless major corrective steps are taken it will double in the next 50 years. Ninety percent of the growth will occur in developing countries, and 90 percent of these people will live in cities, with all their attendant environmental and health problems.

As with environmental degradation, population growth is by and large a medical issue; high growth rates are associated with an increased risk of infectious diseases, with greater maternal and infant mortality, and with the possibility of widespread famine. But human health does not figure prominently in population-policy discussions.

Breaking the Silence

The international effort to begin phasing out and banning ozone-destroying chemicals offers some basis for optimism that solutions to complex global environmental problems can be found. Once the scope of the ozone loss was recognized and its consequences, especially for human beings, were clear, the world community acted decisively. Although ozone depletion will last for decades even with a complete ban (owing to the very slow breakdown of these chemicals in the stratosphere), positive results, though small, have already been



Eliminating species may upset delicate ecosystem balances between predators and prey and between parasites and hosts that now hold some infectious diseases in check.

achieved. In the last year, measurements have shown that the rates of increase in concentrations of the two most destructive CFCs have begun to level off.

But the example of the ozone layer, while encouraging, is not entirely applicable to other global environmental problems, most of which are significantly more complex and may demand much broader social changes. With the issues of greenhouse-gas emissions, habitat destruction, biodiversity loss, and population growth, for example, enormous changes in public policies and personal behaviors will be needed. People may be willing to make these fundamental changes, but only when they have begun to realize that they have no other choice—that is, when they have begun to understand the risks to their health and lives, and to those of their children.

As with the issue of nuclear war, physicians have a critically important role to play. They must help promote this understanding by translating the complexities of global environmental change into practical human-health terms.

But physicians alone can accomplish little; the educational task is far too large and multifaceted. Countless other committed individuals are also needed—including scientists and engineers, policymakers, and concerned citizens—to help educate the public about the consequences to ourselves when we damage the global environment.

How can one explain this relative neglect of human health in the environmental debate? One reason may be avoidance and denial: it is less frightening to talk about the fate of old-growth forests, wolves, and whales than it is to talk about the threat to ourselves.

This is why Physicians for Social Responsibility (PSR), the International Physicians for the Prevention of Nuclear War, and other medical organizations worldwide have recently initiated a wide range of activities on the relationship between the global environment and human health. For example:

■ In October 1992, PSR, along with the Harvard School of Public Health, MIT, the medical schools of Brown and Tufts, the U.N. Environment Programme, and several national environmental groups, held a two-day symposium at MIT on the medical consequences of environmental degradation. More than 700 physicians, environmental scientists and activists, deans and professors from a variety of disciplines, students, and public officials attended, including key U.S. senators and senior policy figures now in the Clinton administration. Follow-up symposia in Chicago and Atlanta have been held this year, and others are in the works for 1995 and 1996.

■ PSR recently published *Critical Condition: Human Health and the Environment* (MIT Press, 1993) because we wanted people to have access to the best and most up-to-date information available on the medical consequences of regional and global environmental change. The book, which will also appear in German, Spanish, and Japanese editions, is being used as a text in courses at public-health schools, has been widely reviewed in medical and environmental journals and is selling well in those communities, and is a major resource at the U.N. Environment Programme, the Senate Foreign Relations Committee, and the White House Office on Environmental Policy.

■ During the past year, the Consortium for Environmental Education in Medicine (CEEM) was formed. Made up of the Massachusetts Medical Society, Second Nature (a nonprofit organization promoting environmental literacy in academic institutions), PSR, and faculty from the medical schools at Harvard, Brown, Tufts, Boston University, and the University of Massachusetts, CEEM will work to introduce environmental education into medical-school curricula, thereby enabling future physicians to participate more fully in environmental-policy discussions.

■ PSR's Project on Global Environmental Change and Health has begun this year to consult on environmental health issues with the White House Office on Environmental Policy, and to hold briefings on the health impacts of environmental legislation for U.S. senators and representatives and their staffs.

We hope that these educational efforts will begin to break the silence about human health in the environmental debate and will contribute to a wider understanding of the potentially catastrophic human costs of global environmental change. We also hope that you—physician and nonphysician alike—will become well informed about these issues and join us in helping to promote this understanding. The health and lives of future generations may depend on it.■

MITnews

FROM THE ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT NOV/DEC 1994

MIT's new biology building on Ames St. (seen partially at right) is connected to the chemical engineering building by a bridge.

NEW REAL ESTATE FOR BIOLOGY

By John Mattill

When biology is defined as broadly as it is at MIT—to include biochemistry, genetics, microbiology, molecular biology, immunology, and neurobiology—it is arguably the most dynamic science in the last half of the 20th century and one of the hottest fields for rapid industrial growth.

MIT's world leadership in this fast-growing enterprise was put into high relief when Phillip A. Sharp, head of the Department of Biology, won a Nobel Prize for Medicine in 1993. Now an extraordinary new building, which was scheduled to be dedicated on October 7, will help the Institute maintain that leading-edge position in an increasingly competitive scientific domain.

At 250,000 square feet and close to $70 million, the new Biology Building (known in the Institute system as Building 68) has been the largest MIT construction project since the original development around Killian Court in 1916, and it is by all odds the most complex. High-tech throughout, it is 365 feet long and 90 feet wide, with six floors and a large penthouse above ground and two levels below ground. Its design is the work of Joan Goody and Robert J. Pelletier, '51, SM '53, BE '55, of Goody, Clancy & Associ-

BUILDING PHOTOGRAPHS: PAULA LERNER

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Taking Note of a Very Big Deal

Feminist writer Gloria Steinem once referred to the federal budget as a statement of national values. If you want to know the priorities of an organization or individual, she said, check out the checkbook. By that standard, it is safe to say that MIT places a high value on its Department of Biology and anticipates an exciting future for the biological sciences. After all, the Institute invested $70 million of its own resources in a new facility to house them. By publishing three articles to mark the dedication of the new building, Technology Review *is following suit.*—SUSAN LEWIS

New Real Estate for Biology

continued

MIT planners, members of the Department of Biology, and the architects for the Biology Building recognized that informal interactions among researchers promote the progress of science. So they set out to design corriders, stair landings, "tea rooms," even areas next to exits (bottom right) so spacious and inviting that conversation is irresistible.

ates, Boston. Roger N. Goldstein, '74, MAR '76, of Goody, Clancy was the architectural firm's project manager.

The building stands near the corner of Main and Ames streets on the site of a fastener factory that was one of the last survivors of Cambridge's turn-of-the-century industrial prowess. It is tied by tunnels to the Center for Cancer Research, across Ames Street in Building E-17, and by both a tunnel and a bridge to the adjacent Ralph Landau Building (Building 66), which houses the Department of Chemical Engineering. The MIT-affiliated Whitehead Institute is just across Main Street.

The Biology Building was a special architectural challenge because it is the first element—and therefore the bellwether—of what will ultimately be a new northeastern sector of the main campus. Envisioned is a courtyard surrounded by the Landau and Biology Buildings and new structures fronting on Ames and Main Streets, with a new campus entrance at that intersection. As they went about their work, the architects for Building 68 were mindful that it will heavily influence the height and style of future buildings in this area of the MIT landscape.

The ground floor of Building 68 is devoted to administrative offices and meeting spaces—large and small lecture/seminar rooms, a lunch room, and conference rooms. Floors two through six, all similar in basic plan, are the heart of the building, with office and laboratory space for a total of 32 laboratory groups—550 faculty, graduate students, postdocs, and technical staff. In the basement are a large teaching laboratory for the two introductory biology subjects and two project laboratories for the growing number of undergraduate concentrators in Course VII (150 majors in the Class of '96). State-of-the-art quarters for experimental animals are in the subbasement, and mechanical equipment for power and ventilation are in the penthouse and basement.

The new facility not only accommodates the demands of the department's research and teaching, but it does so in a way that acknowledges—quite dramatically—the department's concern for communication between students, faculty, and staff.

The building is divided into three segments by two atria—one six stories, one seven stories high—containing stairways and elevators. Off each atrium on each of the five laboratory floors opens a lounge or conference room and a "tea room"—the classic academic venue for a congenial mid-afternoon break with colleagues. The stairways in each atrium are designed for conversation—with wide rails and brass-rail-style footrests for comfortable schmoozing.

"They'll go there and they'll talk," predicted Professor Richard O. Hynes of the tea rooms and adjacent corridors and lounges, whose status as the building's social centers will be boosted by the fact that foodstuffs are strictly prohibited from biology laboratories for health and safety reasons. Hynes was department head at the time the building was conceived and designed and also chair of the departmental Building Committee. In this and many other ways, he says, Build-

ing 68 recognizes more than most MIT buildings the truism that people-to-people interactions are "a driving force" among researchers.

The office and laboratory space on the second through sixth floors is ranged along the outside walls, facing east and west. A center core the full length of each laboratory floor houses the major equipment and facilities for shared use: constant-temperature rooms (refrigerated, heated, or held at ambient temperature), other cell-culturing facilities, electron microscopes, centrifuges, radioactivity counters, electrophoresis and X-ray diffraction machines, and the like.

Instead of a corridor on each side of the central core, there's only one—on the east. If your lab is on the west side, you walk through the core to the corridor—a strategy for saving space as well as for increasing the interplay among students and faculty and between research groups. Furthermore, with or without a corridor, each laboratory space has direct access to its neighbors on each side.

Each of the 40 to 50 laboratories on each floor provides safety for its occupants and containment for their experiments. Each has a hood through which are exhausted ambient air and hazardous fumes from research in progress. In conventional practice, the effluent from each such hood is carried separately to a building's roof. But in Building 68, the architects chose to carry this air to the exterior walls, where it is conveyed in ducts on the outside of the building to a plenum in the penthouse to be exhausted through a few large exhaust fans. This strategy, controversial when proposed because it involves mixing waste streams that may include many different compounds, might be unacceptable in, for example, a chemistry building. But gaseous wastes from biology research (except radioactive

New Real Estate for Biology

continued

***A** building is a balancing act between function and aesthetics: Bldg. 68 features a powerful ventilation system, with easy access for repairs, that becomes, on the exterior, a distinctive aspect of the design. And the labs of Building 68 offer some of the best views in Cambridge.*

gases, which are filtered and vented separately from each source in Building 68) are not usually considered a major hazard. This ventilation scheme saves significant space and cost, increases occupant safety, and provides the opportunity for heat recovery.

The ventilation system also provides a unique exterior feature: The vertical ducts, clad in anodized aluminum, combine with other features to emphasize the vertical aspect of the building. The result is a distinctive facade that reflects the columnar rhythms of the original campus buildings, interpreted in contemporary materials. Furthermore, the muted hum of the rooftop fans can be heard outside the building, contributing to a combined effect of sight and sound that Professor Sharp, for one, finds extraordinary. The building has a "tension that seems to replicate the excitement of modern biology," he says. When he walks past it in the quiet of a Cambridge evening, says Sharp, the building seems to have a life of its own; he half expects it "to rise like a spaceship" from its Ames Street environment.

Facilities in the offices and laboratories are modular and interchangeable, and all utilities—water, electricity, compressed air, propane, vacuum, and the like—are in the ceiling. Everything possible has also been done, says project manager Goldstein, to make the equipment in the cores of each research floor interchangeable. In sum, the interior reflects the Institute's insistence that it be as "recyclable" over time as the original Bosworth buildings of the Cambridge campus.

The design and engineering of Building 68 have involved large numbers: Nine months to select the architect from among 15 competing proposals. Five and a half years from the start of design to completion of the structure. A massive concrete foundation—150,000 cubic feet of ballast slab—dictated by a high water table and adverse soil conditions. Total air-handling capacity of 370,000 cubic feet per minute, of which 70,000 cfm is dedicated to the sub-basement animal facility. Electric power from two 13.8-kilovolt feeders, with redundant transformers and switchgear. A standby 800-kilowatt generator in case of a power outage. Electronic security throughout. Energy-saving glass, heat exchangers to recover heat energy from all the exhausted air, occupancy sensors, and sophisticated variable air-volume controls on the supply and exhaust systems for fumehoods are typical of the building's comprehensive approach to energy conservation.

To the members of the Department of Biology, gathered from four separate buildings and under one roof for the first time in decades, the most exciting aspects of their new accommodation are the things they don't yet know: the new collaborations and the new ideas that will hatch here. □

MORE THAN A BUILDING: AN ENVIRONMENT FOR CREATIVITY

By Mary Haller

A biology professor in-structs a colleague to meet him "at the tree" later for a lunch meeting, motioning to a gnarled pillar of reddish-brown fossilized wood in the lobby. Nearby, a smooth brown band of rippled sandstone, set at eye level into the rough limestone wall, invites the touch of a student passing through on the way to her lab. Farther down the hall, a visitor moves past a wall of hand-glazed tiles, smiling at the shiny, red-orange blobs and black double helix shapes that conjure up microscopic organisms at a heroic scale.

The ancient and the new, the concrete and the abstract, the organic and the manufactured—all are represented in two art works that dramatize the ground-floor corridor and lobby of MIT's new Biology Building. Funded primarily by MIT's "1 percent for art" policy—which ensures that a share of the cost of new-building construction or major renovations will be set aside for art works for the site—two separate sculptural installations were commissioned from artists Jim Melchert and Jim Sanborn.

Both of the installations offer playful and intriguing references to the work that goes on in the building. The works are also a significant addition to MIT's much-respected Permanent Collection of contemporary art. For visitors and occupants of the building, they represent a fusion of art and science that invites the eye, the touch, and the imagination.

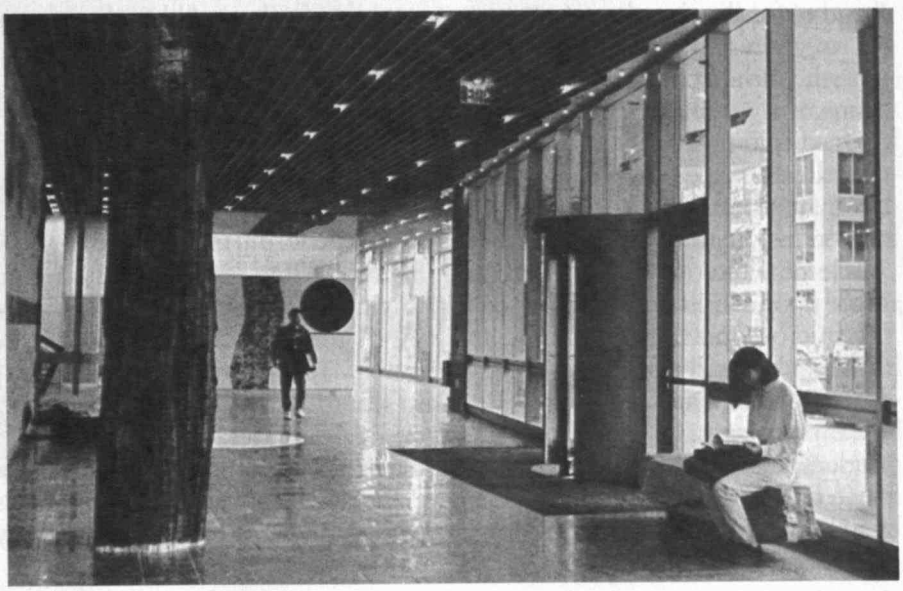
Three years ago, Katy Kline, director of MIT's List Visual Arts Center, sat down with Joan Goody, of Goody, Clancy & Associates, the building architects, and members of the biology faculty to talk about the art component. Their first decision was that the well-traveled corridor would be the most appropriate, most accessible installation site. Far from being tucked into the bowels of the structure, the 350-foot-long corridor is featured prominently on the perimeter; and thanks to a glass exterior wall, it is visible day or night from Ames Street.

After soliciting proposals from a number of artists, the panel was particularly taken by a proposal from California sculptor Jim Melchert: a long wall mural of glazed tiles, hand-painted with lively, abstract shapes. "I showed the committee some glob-like shapes which I hadn't actually thought of as organisms," explained Melchert, former head of the American Academy in Rome. "To my surprise, the biologists responded very positively, identifying them by scientific names!"

Melchert's mural is 14 feet high and 225 feet long, covering the wall from floor to ceiling and flowing around a corner from the main lobby to the building's north end. In addition to the imaginary micro-organisms, the work features abstract geometric and organic shapes, ranging from large double helixes and shiny black circle forms to small globules of colorless glaze that sparkle and reflect the viewer's image. Hundreds of the wall's 2,529 tiles, one-foot square, were hand painted, glazed, and fired in a specially prepared Los Angeles studio where Melchert was able to view his work in 30-foot sections.

Melchert says that he designed the mural "so that it would read both ways: while you're walking alongside it and when you're standing [outside the building], looking at it as you would a painting." The result is a nonrepetitive series of shapes of varying textures, colors, and light patterns that will "come alive with your movement as you pass through space."

"Having walked through long hallways in other buildings at MIT, I am aware of how tedious a pas-



A column of petrified tree, backed by a limestone wall with a band of fossilized sea bed—an installation by artist Jim Sanborn—greets those entering the Biology Building's main door. Like the tile mural by Jim Melchert that begins further down the corridor, Sanborn's installation is visible from Ames Street.

ART PHOTOGRAPH: PAULA LERNER

More Than A Building

continued

sageway can become," Melchert notes. "A person walking past this mural is able to see only a part of it at a time, so it matters which images follow which, regardless of the direction in which a person is walking. What do you see when there's a circle on the wall ahead of you? You see a vertical ellipse. The closer you get to it, the more it expands, until you're alongside it and you see it as a full circle. The notion of having shapes that undergo transformation seemed sympathetic with the nature of organisms that the biologists are studying upstairs."

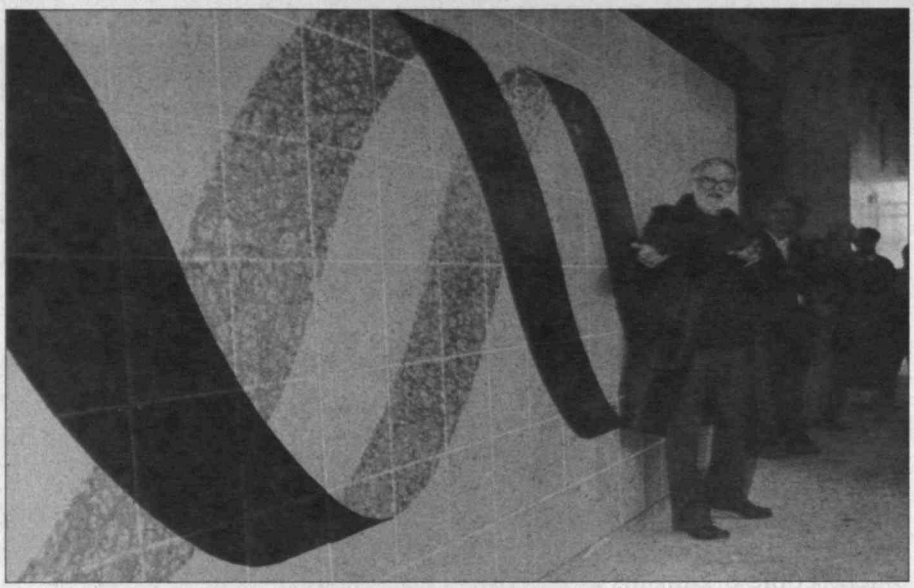
Melchert named the mural "Coming to Light," a title that has a double meaning: First, he says, it refers to "things that are unknown being made known through the activity of biology—new information coming to light." Second, it refers to "the nature of the tile itself, which is to reflect light and play with it."

Jim Sanborn, on the other hand, describes his collection of pieces in the south end of the lobby as a "macro-micro-biological installation." The work involves integrating architectural materials containing life forms into the building, and it reflects his past training as an archeologist. A band of fossilized sea bed in the form of rough-cut limestone blocks is set into the surface of the wall, while sections of a petrified tree extend in a rugged column from floor to ceiling. Benches made of irregular slabs of green quartz create a viewing area for the "micro" part of the installation: a circle of white marble set into the floor upon which is projected images of microscopic organisms, actual slides submitted periodically by the building's occupants.

Sanborn says he likes to create works specific to the activities of people in the building, a concern reflected in what is perhaps his best-known work: an installation for the Central Intelligence Agency headquarters in Langley, Va., involving encoded text. "They still haven't cracked the major part of it," he notes.

Coming up with an idea for the MIT project was "the fun part," Sanborn said, but bringing it to fruition was arduous. It took more than two years to find a section of petrified tree of the right diameter and length and in small enough pieces to physically move and position in the building. Even then, positioning the four pieces, each two and a half feet in diameter and weighing nearly a ton, was "a very dangerous, very stressful installation." Another challenge was finding a projection system and light sources that could run continuously for 12 to 14 hours a day; Sanborn finally solved the problem with metal halide lighting (the kind used for architectural and parking-lot lighting) and a projector redesigned with help from a NASA engineer.

Sanborn's work gives "historical perspective to a modern building," observes Department Head Phillip Sharp. Calling it a documentation of "living organisms locked into eternity," the List Center's Katy Kline feels it is "a wonderful counterweight" to the movement in Melchert's tile mural. Sanborn's installation was made possible in part by a gift from Professor Emeritus of Biology Boris Magasanik, honoring the memory of his late wife, Adele.



Artist Jim Melchert introduced members of the Department of Biology to his 225-foot-long tile mural, which includes this double helix of heroic proportions.

Both installations have found favor with the building's architects, who worked closely with the artists to implement their ideas. "The experience of moving through the public corridor is changed because of these pieces," says project manager Roger Goldstein, '71, MAR '76, of Goody, Clancy. "The building is giving back to the street itself and to the pedestrians," says Goldstein, noting that at night, the glow of the corridor lighting reflected off the tile mural augments existing street lighting, contributing to the sense of security for people walking in the area.

"The art has both fluidity and energy," says Sharp, who participated in the planning for the installations; he, for one, is "quite thrilled" by them. Though he expects that it might take some time for everyone to get used to the works and understand them, Sharp thinks that is as it should be. "Art *should* surprise you. . . . If art is so routine that you don't have to think about it and you feel totally comfortable with it, then it's not right." □

MARY HALLER is the director of arts communication at MIT.

ART PHOTOGRAPH: BEN E. WATKINS

THE PATH TO LEADERSHIP

By Richard Anthony

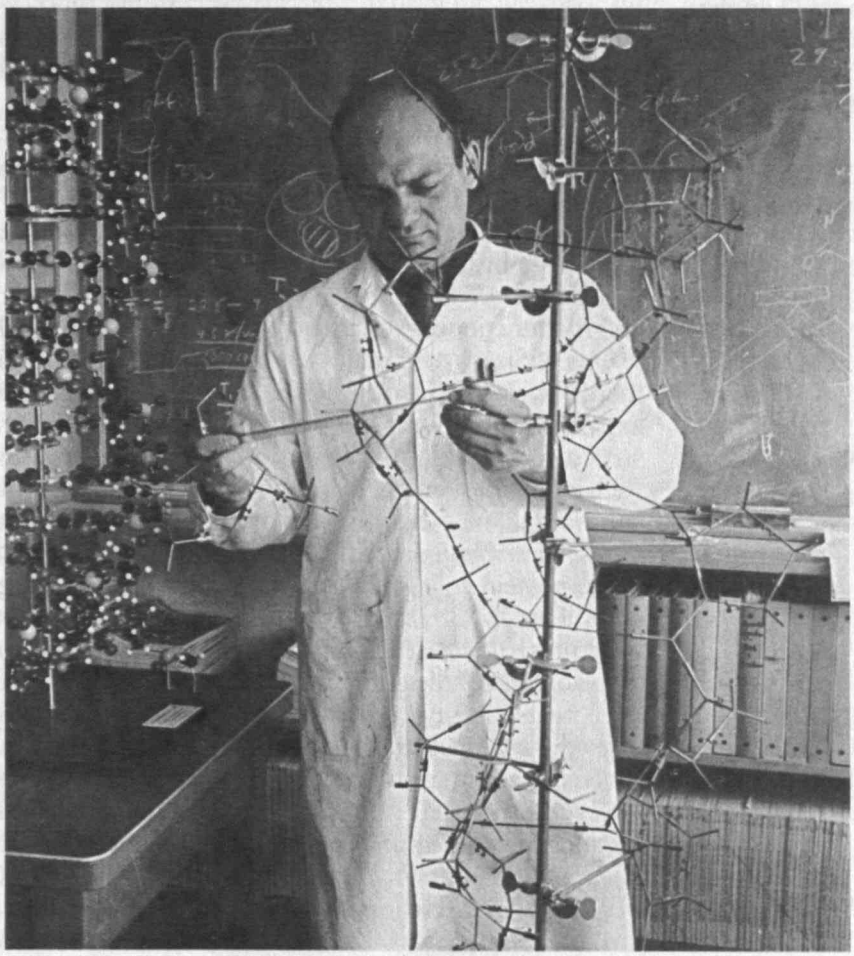
Over a span of roughly two decades, the MIT Department of Biology went from being a minor player in the field to one of the world's leaders. How did it accomplish this feat? Luck and timing played a role. So did a strong institutional commitment. As in most human enterprises, though, in the end it was the people that made the real difference.

The department can claim impressive early achievements. In the late 19th century an Institute biologist, William Thompson Sedgwick, made a major contribution to the then-new science of epidemiology by tracing typhoid outbreaks in New England cities to waste runoff in the Merrimac River. Not long thereafter, MIT biologist Samuel Prescott, working with William Underwood of the Underwood food-processing clan, showed that heating foods in prescribed ways killed bacteria without destroying flavor, and so prepared the way for safe food-canning methods.

Still, says Irwin Sizer, who joined the department in 1935, there was little about the biology program as he first experienced it to suggest its future eminence. The department was small, with just 14 faculty, and its main mission was teaching classical biology. "I taught freshman botany and zoology," says Sizer. "I remember that the first semester, we would study dried ferns. The second semester, we would dissect earth worms." Sizer, trained as a biochemist, emphasizes that he's not disparaging classical biology, but by the 1930s, a "new biology" was emerging, focused on the cells that make up organisms and on the atoms and molecules from which such cells are formed.

In 1942, MIT President Karl Taylor Compton named as department head Francis Schmitt of Washington University in St. Louis. Schmitt had made his reputation by seeking quantitative answers to biological questions, using such techniques as studying molecules with X-rays. His was an approach consistent with the new biology, and it was on Schmitt's watch that the department began to shift to a less classical orientation.

That shift continued with the arrival of John Buchanan, a well-regarded University of Pennsylvania biochemist, who launched a new program in his field. The department was also venturing into technologies like the electron microscope. Still, a decade later, the department remained relatively small and divided between classicists and proponents of the new biology.



ALEXANDER RICH

The next noteworthy event happened not at MIT but at Cambridge University, where in 1953 Francis Crick and James Watson reported that they had worked out the chemical structure of DNA—the gene molecule. The discovery offered critical insights into how traits like eye and hair color get passed from one generation to the next. The mechanism, the pair's report made clear, is information embedded in the chemical structure of DNA, the now-famous "double helix."

The finding raised the prospect of techniques that would let scientists link specific genes with specific traits, and specific genetic flaws

PHOTOGRAPHS: THE MIT MUSEUM

The Path to Leadership

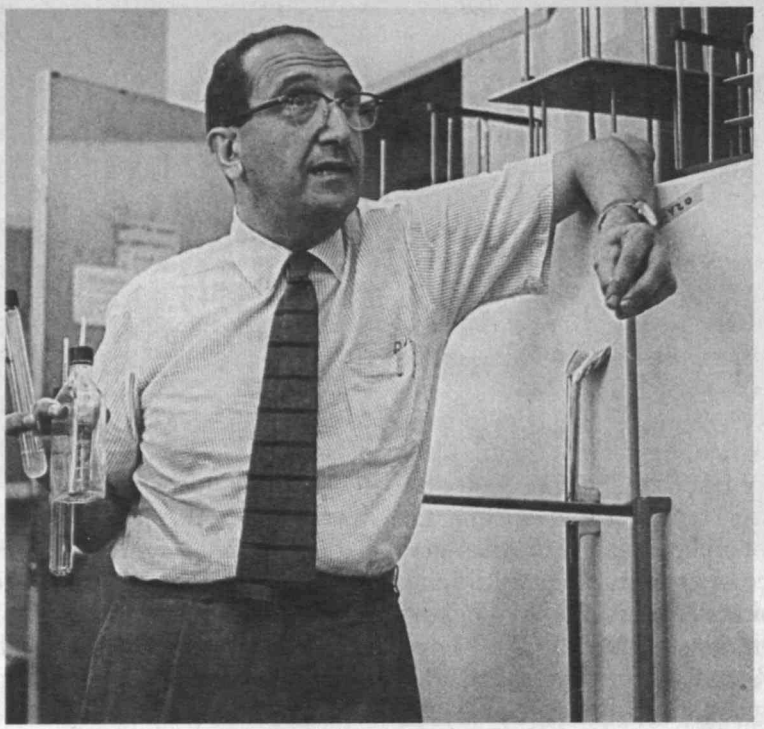
continued

with specific problems, including inherited diseases. But while many observers date the birth of what is referred to broadly as molecular biology to the Watson and Crick report, it took the world a while to realize a revolution was under way, says Alexander Rich, the William Thompson Sedgwick Professor of Biophysics. "When the report was published," he notes, "it had no impact at all outside a few research centers."

Irwin Sizer was one of those who did pay attention to the report. And when he was named acting head of biology in 1957, he quickly began to put the discovery's implications to work. "My idea was that we should give up classical biology and concentrate on molecular biology," he says. That break with tradition was not universally applauded. Among its opponents was the Biology Visiting Committee, which, Sizer recalls, recommended that he be replaced. But the late Julius Stratton, '23, then the Institute's acting president, supported the new head and his ideas.

Sizer wanted to reshape the department quickly, which meant hiring scientists who had already made names for themselves. It looked like a tough assignment. Although Buchanan had built a group in biochemistry—"We were really world leaders in that area," says Sizer—the department had few other obvious sources of appeal to established faculty who specialized in aspects of the new biology.

Even under these circumstances, Sizer showed a flair for recruitment. One early appointee, for example, was Vernon Ingram. An Englishman who had worked at Cambridge University, Ingram was by then finishing up elegant experiments showing that tiny changes in proteins can have a massive impact on their biological activity. Specifically, he showed that a change in just one out of the hundreds of chemical building blocks that make up hemoglobin (the oxygen-bearing molecule in red blood cells) can lead to sickle-cell anemia—a brutally painful disease in which the body produces misshapen and malfunctioning red blood cells.



SALVADOR LURIA

One of Sizer's next major appointments was Alexander Rich. An expert in using X-rays to probe the structure of biological molecules, Rich had published papers with Watson, and, in collaboration with Crick, had worked out the makeup of the protein collagen. Rich arrived at MIT in 1958 from the National Institutes of Health, already well along on one of the efforts for which he's best-known: describing the three-dimensional structure of transfer RNA, an intermediate molecule that plays a crucial role in applying the information bound up in DNA to the manufacture of proteins.

What was it that inspired someone of Rich's stature to come to MIT? One factor was the hiring of Ingram, whom Rich had recommended. "I also was interested in the spirit of the place with regard to research, which was very good," he says. Physicists, too, played a significant role, and their interest in the new molecular biology further enhanced MIT's attraction for Rich.

The late Salvador Luria also arrived in 1958. An Italian who had left his homeland to escape fascism in the late 1930s, Luria came to MIT as a visiting professor. Sizer, Rich, and others, though, were very eager to have him stay. The department, notes Sizer, was weak in Luria's specialty of microbiology—the study of minute organisms such as bacteria. Microbiology was a priority because it offered a highly promising arena for probing genes. If you study genes by inducing mutations in rodents, you have to wait weeks for each successive generation to be born. If you use *E. coli*—a very common bacterium—you can double the population in under an hour.

Luria not only offered a speciality that the department needed, but he was also a scientist of enormous stature: he went on to win the 1969 Nobel Prize for his findings about how genes mutate. And, as his new MIT colleagues soon learned, he was

an excellent teacher. "MIT students are never afraid to disagree with their professors," recalls Sizer, "and Luria had this great way of putting them in their place—explaining the ways in which they were wrong, but also how they were right. The kids loved it." When Luria decided to stay, therefore, it was a coup for the department.

Luria's decision helped secure another key appointment. Boris Magasanik, a distinguished microbiologist at Harvard Medical School—and, like Luria, an émigré who fled Europe to escape fascism—was lured to MIT in 1960. "I doubt I would have come if Salvador hadn't been here," he says. Such appointments helped create a critical mass of talent, making the department increasingly attractive to top faculty and students. MIT's lack of long-established programs in biology also helped. "We could define biology the way we wanted to define it," notes Magasanik, who headed the department from 1967 to 1977.

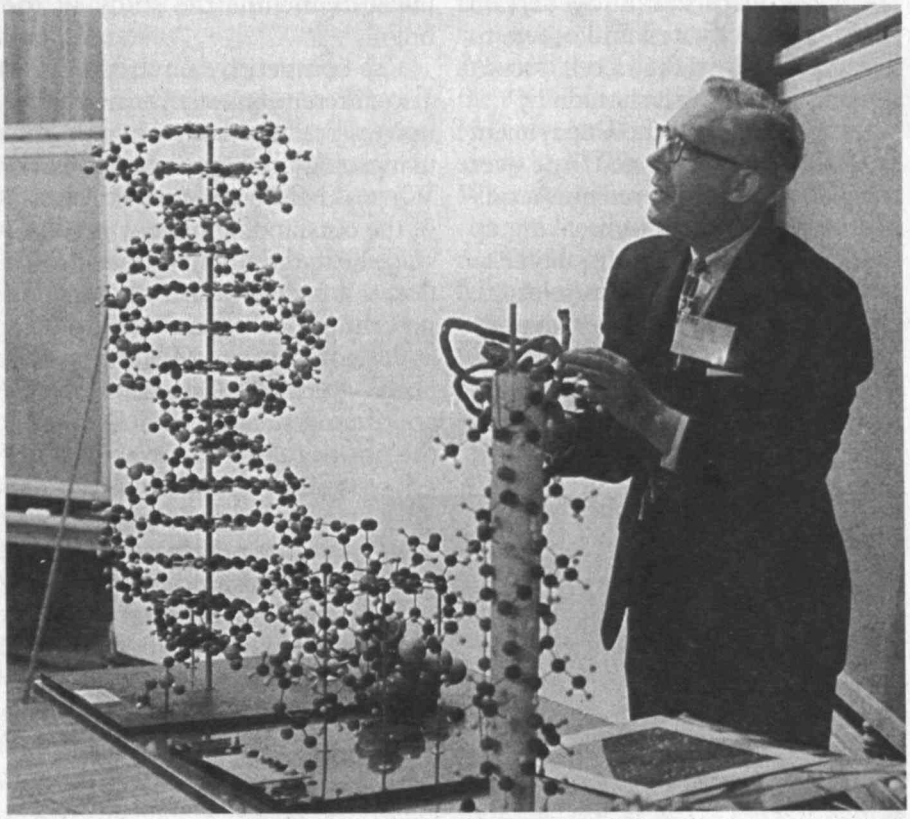
To build MIT's breadth as well as its depth in biology, says Magasanik, the department evolved what turned out to be a highly productive strategy: make appointments in areas where you see a gap in the resident expertise, but which are *related* to what is already being done here. That way, he explains, new appointments always have existing faculty they can talk to. As time went along, Magasanik adds, the department began focusing its recruitment efforts on young biologists just completing their training instead of on established faculty.

In another important step, the department also decided that genetics and biochemistry would become the basic subjects for the undergraduate majors. "That was a big deal," Magasanik says, "because up until then, subjects like biochemistry had been regarded as things that you only teach to graduate students."

The creation of affiliated centers further boosted the department's growth and evolution. In 1972, for example, the National Cancer Institute agreed to fund a research center at MIT. The Center for Cancer Research, initially headed by Luria, was and is staffed by Institute biologists. It has been a remarkably successful enterprise, as the names and achievements of some of its scientists suggest:

- In the late 1960s, David Baltimore, '61, discovered a virus-born enzyme that lets RNA serve as a template for DNA, and that became a valuable tool for scientists seeking to insert DNA from one organism into the cells of another. For this finding, Baltimore—who recently resumed his MIT faculty appointment after serving as president of Rockefeller University—was named co-winner of the 1975 Nobel Prize in Medicine or Physiology.
- A decade later, Phillip Sharp and his associates showed that genes in humans and other higher organisms, unlike those in bacteria, are made up of stretches of DNA interrupted by sometimes lengthy spans of "nonsense" DNA. Sharp, who now heads the department, was named a co-winner of the 1993 Nobel Prize for this stunning discovery.
- A geneticist who joined the faculty after finishing his doctorate, Robert Weinberg, '64, PhD '73, was the first to isolate an "oncogene"—an altered gene that can cause cancer—from a human tumor. Weinberg's honors include being named *Discover* magazine's "Scientist of the Year" for this achievement.
- When Susumu Tonegawa joined the cancer center in 1981, he had already completed his elegant studies of how the immune cells called "B cells" attain their remarkable versatility in attacking dangerous microbes and other threats to health—work for which he was to win a 1987 Nobel Prize. He has gone on to make a similar contribution to the understanding of so-called "T cells"—the master cells of the immune system.

The Center for Cancer Research served as a seedbed for the next departmental offshoot: the Whitehead Institute for Biomedical Research. The Whitehead is an inde-



IRWIN SIZER

The Path to Leadership

continued

pendent research enterprise located almost across the street from MIT's new Biology Building. Many Institute graduate students work in Whitehead labs, and its senior scientists hold faculty appointments in the MIT Department of Biology.

Like the cancer center, the Whitehead allowed MIT to expand its reach in the biological sciences. In the center's case, one of the focal areas is immunology—the study of how the body combats viruses and other disease-causing agents. The Whitehead, meanwhile, concentrates on developmental biology, which deals primarily with organisms in the embryonic stage. Developmental biologists seek to answer such questions as "How does an undifferentiated cell develop into a hair cell or a muscle cell?" explains biochemist Gene Brown. "What are the molecular mechanisms that allow certain genes to be activated and others to be suppressed, so that a cell doesn't become something it shouldn't?"

Some features of the Department of Biology have changed little over time. For example, it remains a unified whole. The idea of breaking up the department surfaces from time to time but has always been rejected. "We could have had four departments: biochemistry, microbiology, genetics, and cell biology," says Brown, who was department head from 1977 to 1985 and also served as dean of science. "But one of my goals was to make sure that it never got fragmented in that way."

In other respects, though, the department has changed dramatically. It now has 57 faculty, and the 185-member graduate-student cohort undoubtedly dwarfs its earlier counterparts. Moreover, much of the department's current research relates more closely to applications, especially in medicine, than in the '50s and '60s. MIT investigators have been involved in efforts from pinpointing the gene that causes Huntington's disease to creating a new cancer vaccine. Department members routinely collaborate with colleagues from medical centers like the Massachusetts General and Children's hospitals.

In other new directions, the Department of Biology recently boosted its neuroscience capabilities by joining with the Department of Brain and Cognitive Sciences to create an MIT Center for Learning and Memory. The center is headed by Susumu Tonegawa, whose current interests include the study of the brain.

The competitive environment is also different, mainly because other universities have built strong molecular biology programs of their own. Whereas MIT once attracted "most" of the outstanding biology graduate students in the country, Gene Brown notes, it now enrolls only "a good percentage of them." Even with added competition, MIT is a powerhouse, and a key to the department's continuing success, says Brown, is the priority given to attracting top-flight young faculty. "You have to make sure that the young people you bring in are outstanding; and after that, you do what you need to in order to allow them to succeed."□

GENE BROWN WITH A STUDENT

RICHARD ANTHONY is a freelance writer specializing in science and medicine. He works part-time in the MIT Office of Communications.

FROM ALUMNI/AE ASSOCIATION PRESIDENT R. GARY SCHWIEKHARDT, SM '73

A Whole New Take on Graduate-Student Alumni/ae

As the first graduate-student exclusive (GSE) president of the MIT Alumni/ae Association, I will be focusing a substantial effort this year on building graduate-alumni/ae involvement.

The value of participating in MIT alumni/ae activities is not always obvious for graduates whose first degree was earned elsewhere. Undergraduate affiliation is typically rooted in close personal friendships that are renewed and cemented by reunions.

This undergraduate loyalty is so well documented that both GSEs and professional alumni/ae organizers alike once assumed that ties between GSEs and their graduate

institutions would never be strong. But at MIT, that conventional wisdom is being replaced by a whole new mindset.

Nolan T. Jones, SM '54, is an example of the many GSEs who are looking for a closer affiliation with MIT. "There was some reluctance for graduate students to associate with the undergraduates during their studies and immediately after graduation, but I think that evaporates in later years," Jones wrote in a recent letter to me. "I think MIT should do something for GSE alumni."

Jones went on to note an admitted hurdle: "Organizing separate activities as classes or as courses would require work for which there are no clear volunteers."

Motivating volunteers to come forward and supporting them in their efforts is the job of the Association leadership and the professional staff. We must help create and market opportunities to participate and also make a persuasive case for why volunteering for MIT is not a one-way street.

From MIT's point of view, it's not hard to argue for strengthening its connections with its graduate alumni/ae, starting with the numbers: In 1993–94, MIT had 4,509 undergraduates and 5,281 graduate students. The 1994 Alumni/ae Register lists 73,813 alumni/ae for whom we have current addresses; 39,470 undergraduate alums (53 percent), and 34,343 GSEs (47 percent). GSEs thus are approaching half of the living alumni/ae.

MIT's graduate population has undergone a dramatic rise since the mid-1970s. As the number of GSEs increased, so did their involvement with MIT and the Association. A few indicators: in addition to myself, current GSE members of the Association Board of Directors include Leslie Hruby, SM '73, and Melinda Skaar, SM '87. Karen Mathiasen, SM '71, was the chair of the Alumni/ae Fund Board for 1991 and '92. And last year 9,730 GSEs contributed $3,978,412 to the Fund.

My own experience and conversations with active GSE volunteers yield similar reasons for our involvement:

- MIT alumni/ae are some of the most interesting and open people you could hope to encounter. They are from wide-ranging backgrounds and are eager to share experiences, points of view, and professional and recreational activities.
- MIT Alumni/ae Association activities provide an avenue through which members can contribute to the growth and vitality of what is arguably the world's best technological and scientific institution. A good example of this aspect of alumni/ae activism is the Educational Council, through which volunteers help to identify and recruit some of the ablest students.
- Thousands of participants in Association fund-raising have the satisfaction of knowing that they provide a significant and growing source of financial support to the Institute (particularly financial aid), which is increasingly critical as government support declines.
- Volunteer involvement—both organized and informal—can benefit a person's career and business opportunities, professional development, and ties to the frontiers of science and technology.

Nurturing opportunities for GSEs to share in these activities and satisfactions is the specific responsibility of the staff of the Graduate Alumni/ae Program (GAP), headed by Kathy Battillo.

In 1993-94, GAP collaborated with most of the 22 MIT departments to host 33 different events. Of particular note were receptions for MIT graduates at the annual meetings of 13 professional associations, such as the American Society of Mechanical Engineers and the American Institute of Architects. Other departments hosted seminars on campus, published alumni/ae directories, and organized regional gatherings. Within the past year and a half, two departments sponsored social and intellectual events to celebrate anniversaries: the 15th for the Technology and Policy Program and the 25th for the Woods Hole Oceanographic Institution.

Over the long term, GAP would like to see every department and program host at least one event per year that will reinforce ties to and among their graduate alumni/ae.

This focus on graduate alumni/ae involvement is still relatively young. We are seeking more ideas on how GSEs can become more active and visible as volunteers. What programs will appeal to graduate alumni/ae? Are there any that might be cyclical—as are the undergraduate reunions?

Would a one-day symposium sponsored by a particular school—Humanities and Social Science or Sloan, for example—attract alums? How can we best serve some 7,000 GSEs who live abroad? Should the Association create a permanent advisory board made up of graduate alumni/ae?

We are also interested in hearing more about experiences GSEs have had with MIT and the Association, and what they find are the benefits of their MIT connections.

Everyone knows that graduate study at MIT can change your life. What's not so well understood is that change also works in the opposite direction: graduate alumni/ae have left and will continue to leave their mark on the Institute and on the Alumni/ae Association.

R. Gary Schweikhardt

R. GARY SCHWEIKHARDT, SM '73, President, Association of Alumni and Alumnae of MIT

Note: *Ideas, comments, and questions about programs for graduate alumni/ae may be directed to Kathy Battillo, phone: (617)253-6326; fax: (617) 258-7264; electronic mail:<KLB@MITVMC.MIT.EDU>; regular mail: MIT, 201 Vassar St., Cambridge, MA 02139.*

MIT Clubs Are Alive and Well and Awaiting Your Membership!

Across the nation and around the world, MIT Alumni Clubs draw thousands of alumni/ae, parents, students, and friends to a broad range of social and educational activities. Since MIT clubs reflect the diversity of our alumni/alumnae body, events range from faculty speakers to career workshops, from plant tours to opera, all in an effort to promote the Institute and provide enlightenment about its programs. In addition, a number of clubs have a public service entity in which one may find people tutoring high-school students or painting a shelter for battered women.

Club leadership is drawn from local alumni/ae volunteers who serve as officers or board members and often rise to positions on Alumni/ae Association national boards and committees. Each club sends out annual membership invitations, usually with its first fall event announcement. If you haven't received your invitation yet, respond now by looking up the club president or alumni/ae staff person in your area on the following list.

We look forward to seeing you soon and often at MIT Club activities and welcome your support.

Janet Serman

JANET SERMAN
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Hajime Mitarai '65 EE
81 (3) 3758-2111 (B)
81 (3) 5482-5120 (B Fax)

KOREA, REPUBLIC OF ▼
MIT Alumni Association
of Korea
Mong Joon Chung
GM '80
82 (2) 733-6764 (B)
82 (2) 735-2755 (B Fax)

LEBANON ■
Nicolas Elie Chammas
CE '87
961 (1) 202165 (B)
961 (1) 202175 (B Fax)

MEXICO ◆
Gonzalo Maldonado
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52 (5) 596-2492 (B)
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PAKISTAN ■
Farrokh K. Captain
'66 CH
92 (21) 776-4101 (B)
92 (21) 776-4108 (B Fax)

PHILIPPINES ▼
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Gerardo A. Borromeo
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PORTUGAL ◆
Charles A. Buchanan, Jr.
SL '73
351 (1) 396-0297 (B)
351 (1) 396-3358 (B Fax)

PUERTO RICO ▲
(see also: National Clubs)
Tomas A. Gonzalez
Laugier '80 ME
(809) 792-5600 (B)
(809) 792-3990 (B Fax)

SINGAPORE, REPUBLIC OF ▼
Asad Jumabhoy GM '86
65 747-8010 (B)
65 747-8166 (B Fax)

SPAIN ◆
Asociación MIT De España
Jesús Guerra NU '79
34 (1) 309-2036 (B)
34 (1) 401-4954 (B Fax)

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Alan E. Hodgkinson
'82 EE
41 (41) 23 90 74 (H)
alan@softxs.ch (e-mail)

TAIWAN, REPUBLIC OF CHINA ▼
MIT Alumni Association in Taiwan, R.O.C.
Chi-Kuo Mao CE '83
886 (2) 349-2020 (B)
886 (2) 381-1892 (B Fax)

THAILAND ▼
Sivavong Changkasiri
'58 ME
66 (2) 245-9866 (B)
66 (2) 246-4269 (B Fax)

TURKEY ◆
MIT Alumni of Turkiye
Ahmet Coskun ML '67
90 (212) 257-6238 (B)
90 (212) 257-7125
(B Fax)

URUGUAY ■
Julio C. Franzini '52 EE
598 (2) 409141 (B)

VENEZUELA ■
Asociación de MIT de Venezuela
Alfredo J. Peralta-Maninat '54 CE
58 (2) 239-7806 (B)

ClassNotes

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Please send news for this column to: Class Notes Editor
Technology Review
201 Vassar St.
Cambridge, MA 02139

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Some of you may recall meeting Mrs. **Donald Way** at one of our reunions. Mr. Way, our class president, passed away prior to our last planned reunion. Mrs. Way had planned to attend, but the reunion had to be called off because the few still alive could not make it. I just learned that Mrs. Way injured her shoulder and has been bedridden in a cast since March 1994. If you would like to send a card, her address is 846 Cedar Terrace, Westfield, NJ 07090.

Francis Weiskittel responded to our request to tell us about himself. He is now in his 96th year. He sent me a Pennzoil trade magazine in which there is an article on his life. We find that he and his father had a foundry for making cast-iron parts and articles for home and commerce. The income led him to invest his funds in the stock market, and he decided oil was a required commodity. He has had investments with Pennzoil and its predecessors for over 77 years.

Speaking of stocks, he says you do not have to pay capital gains taxes if you keep the stock. He says, "My view is if I've got a stock in a good company, why sell it?" On the personal side, he enjoys life with his son as a companion and helper who makes his life worth living. He adds, "I am walking and using a cane. My hearing is very bad, also my vision, but I am holding the arm of my son, Anton, who is now a great blessing."

I quote from a recent letter from **Robert Burns MacMullin**. "I am reading the *Tech Review* and the 1919 class news. As our ranks thin out, we seem to live longer these days. So by means of various electronic gadgets, we keep up with the news."—**Bill Langille**, secretary, Box 144, Gladstone, NJ 07934, (908) 234-0690

20 75th Reunion

In the August/September 1994 issue of the *Review*, we reported the death last May of **Harold Bugbee**, longtime class secretary, active alumnus, and 53rd president of the MIT Alumni/ae Association. At that time we had few details. We are grateful to his daughter, Barbara Bugbee Foley, for sending additional information.

Mr. Bugbee, who most recently lived in a retirement home in Woburn, Mass., was a twin brother of **Percy Bugbee**, who died in 1989 and was head of the National Fire Protection Association for 30 years. The Bugbee twins delighted in telling the story of how their professors at MIT could never tell them apart but were embarrassed to admit it. Taking advantage of this fact, when "Bugbee" was called upon, whomever had "taken the nightly turn at homework would promptly jump up and deliver."

In a booklet prepared for his grandchildren, Harold Bugbee relates one way the twins were distinguished: Chicken pox left a small, round mark in the middle of Percy's forehead. "'P for Percy, P for pox' became a handy way to remember which twin was which, much to Percy's annoyance at the time."

HAROLD BUGBEE

1898–1994

While at MIT, Harold, who had learned to play the cello at an early age, was involved with the musical club and orchestra activities. Both Bugbees were in ROTC and Theta Delta Chi, as was their older brother, Jim, also a graduate of MIT.

After completing a degree in management, Harold went to work for United Drug Co.'s Rexall factory in Boston. From there, he took a position with the Walter B. Snow advertising agency, where he became head and principal owner of the business after Snow's retirement.

In concluding the story for his grandchildren, Harold writes: "Much of my recent reading has been about the unfolding, exciting, and expanding universe of which our world is now recognized to be but an infinitesimal speck. How I wish I could live, like you, into the next century when the knowledge of and exploits in outer space will develop far beyond our current small beginnings. Surely, this will be the most thrilling period of all history. I envy you that future.

"Realizing full well that advice from the older generation is seldom welcome and almost never heeded I, nevertheless, permit myself a few parting words. I urge you to cultivate and vigorously exercise your capacity to enjoy and appreciate the truly good things in life. There is such an abundance of them: the joy of learning, of physical and mental achievement, of work well done, of affection, close kinship, and loyal friendship; of music and art and biography and history and vicarious adventure through books, and scenery and travel and home and doing things to make others happy, especially those you love.

"Here's wishing you a productive, useful, colorful, exciting, and adventurous life. May it prove as happy a life as that of your grandfather!"—*ed.*

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M. Harry Naigles, engineering administration, deserves a medal for promptness as the first to respond to one of several letters appealing for emergency aid in the form of news for class notes.

Mike tells us of significant success by his two grandsons thereby earning congratulations to a happy grandpa at 48 Seneca Ave., Yonkers, NY 10710; and our thanks for relieving your secretary of prospective embarrassment for missing class notes.

The young men were graduated from Harvard in 1991 and 1993 respectively. The older one received a scholarship at Dartmouth where he is studying for a doctorate. The younger grandson is seeking a master's degree at the New England Conservatory of Music.

Mike requests his best wishes be extended to fellow classmates.

We also enjoyed a long phone conversation with our nearest classmate, **Arnold R. Davis**, chemical engineering, who lives some 40 miles north at 95 Orchard Lane, Berkeley Heights, NJ 07922.

Arnie or Jeff, as he was known, was one of those rare "junior freshman," some 150 of whom, early in 1918, joined the Class of 1921—last of the small MIT classes with about 750—to enable more efficient use of enlarged facilities at the new Cambridge site, which 1921 was the second class to enter, and to speed MIT's response to World War I demands for additional technical personnel.

Arnie told us he is "reasonably well but legally blind," in that reading is difficult and he cannot drive a car, but he adds, "I go to the supermarket every day."

His wife died a year ago after a marriage of 67 years and his only daughter and the eldest of three sons live with him.

Interested in research and development of rubber, his first job was briefly with Firestone and he spent subsequent working years with American Cyanamid, rising to manager of research on rubber and then manager of technical services on rubber chemicals until retiring in 1965.

Born on a farm in Montville, Maine, and the eldest of 16 children, 10 of whom still are living, Arnie prepared for MIT at Milford, Mass., High School.

At the Institute, he was active as a member of the Chemical Engineering Society and Technology Athletic Club.

We still need more letters or phone calls to provide news for your enjoyment next month. Who will be the first to compete for that mythical medal?—**Carole A. Clarke**, president and secretary, 608 Union Lane, Brielle, NJ 07830, (908) 528-8881; **Samuel E. Lunden**, assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 96274, (310) 833-1480

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Please send news for this column to: Class Notes Editor
Technology Review
MIT, W59-217
Cambridge, MA 02139

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I have one death to report. **Robert A. Hall** passed away March 28th at the Ellis Nursing Center in Norwood, Mass. Robert was an electrical engineer and worked for Stone & Webster. While at the Institute he was a member of the Banjo Club, Mandolin Club, and a cornetist in the MIT orchestra.—**Royal Sterling**, secretary, 2350 Indian Creek Blvd. W., D-201, Vero Beach, FL 32966

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The Alumni/ae Association sent me notices of the passing of two classmates. A telephone call from her daughter to the Association told of the death of **Helen (Mrs. John) O'Rourke** on May 18, 1994. Helen held a degree in architecture. She was living in Longwood, Fla., at the time. . . . **Everett C. Atwell**, of Greensboro, N.C., died April 9, 1994, as reported by his son, Alan G. Atwell.—Co-secretaries: **Katty Hereford**, 237 Hacienda Carmel, Carmel, CA 93923; Col. **I. Henry Stern**, 2840 S. Ocean, #514, Palm Beach, FL 33480

25 70th Reunion

Court Worthington did make his trip to Switzerland as planned. He spent about two weeks at his son's home there in June.

It is with sorrow that the passing of **Alan W. Crowell** must be reported. He died on April 10, 1994, in Sarasota, Fla. Al worked for many companies during his career, usually in sales or advertising. He was last employed by the EMC Co. of Fort Worth, Tex., as sales manager. When he retired in the late 1960s, he moved to Sarasota and in 1984 he moved to a nearby retirement home. When reunions were planned, Al was one who could be relied on to attend. However, he was missed at both the 60th and 65th. He made contributions to the Alumni/ae Fund regularly. His '93–94 gift was sent by someone after Al died. A page from Al's desk calendar was enclosed with his gift, June 30 circled and a note written that read as follows: "Don't forget—make sure my pledge for the MIT Alumni/ae Fund is sent by June 30." No information regarding survivors is available.—**F. Leroy "Doc" Foster**, secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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Please send news for this column to:
Donald S. Cunningham
secretary
c/o 132 Middle St.
Braintree, MA 02184

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As this deadline of August 5 for the Class Notes approaches, your secretary **Joe Burley** is cruising the coast of Maine in his *Flying Gull* with some of his family but no computer or typewriter. Joe has always enjoyed the challenges and relaxations of sailing. He has asked your assistant secretary to write this issue.

Russell R. Smith, Course V-A, claims to be '27's "greatest procrastinator." He has written to us after 66 years. (Don't let him get away with that honor without challengers—we would like to hear from you, too.)

Initially, Russ was involved in the electrification of the Pennsylvania Railroad. Subsequently, he developed power transistor static switches and converters, and then designed military aircraft systems during World War II. Later, he worked on aircraft jet engine controls and developing the electric power supply for the abort sensor assembly on the lunar landing module that went to the moon on Apollo 1.

Russ retired in 1967, lived on one-and-a-half acres in Avon, Conn., for 30 years, saving string, mowing the lawn, chopping wood, and trying to analyze the stock market as many of us have done. He has been married for 62 years, has two daughters, a granddaughter, and a 2-year-old great-grandson.

Russ writes: "A little philosophy: considering my great-grandson is 2 years old and contemplating the changes I have seen since my actual horse and buggy days starting in 1905—what will he see through the 21st century? Unimaginable! Further, considering the span of years lived by family members I have known, from one grandmother born in 1840 to my great-grandson who could possibly survive into the 2090s—what the world was and what it may evolve into (if it survives), that is a fantastic fantasy."

Russ and his wive moved to Boalsburg, Pa., in 1993 (next door to Penn State in State College) as volunteer consultants to their great-grandson.

Two classmates died in February 1994: **Peter J. Jerardi**, mechanical engineer, of Trotwood, Ohio, and **Arthur J. Tacy**, electrical engineer, of Westborough, Mass. I hope resume details will come in a later issue.

Now that you are sending holiday cards, please send one with *your update* to Joe Burley at his Florida address below. Regards.—**Larry Grew**, assistant secretary, 21 Yowago Ave., Branford, CT 06405; **Joseph C. Burley**, secretary, 1 Harborside Dr., Delray Beach, FL 33483

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While pondering the problem of some sort of news for our Class Notes for this issue of the *Review*, I have been looking at the notes for other classes in the last (Aug/Sept 1994) issue at hand, and have arrived at a tenuous conclusion. Our Class of '28 has perhaps reached the point, as have other classes, where the prevailing item of news is that of recent deaths. Perhaps those who were in electrical engineering classes and may have used the Timbie & Bush text can appreciate a comparison to the synchronous motor which, when reaching the critical load or point in its speed/torque curve, pulls out of step and ceases to function.

Exceptions in the notes to the above conclusion range from news about Herbert Larner, '18, who had received the Surgeon General's Medallion for his lifetime efforts in milk pasteurization and other healthful activities and at 100 endorses the drinking of acidophilus milk, to the poem in the '25 notes credited to George C. Wales of the Class of 1889 titled "Liquor and Longevity," regarding the short life span of members of the animal kingdom.

To which I will add that for the past 49 years since return from World War II I have had a dish of rhubarb sauce for breakfast every morning of the year, which may or may not be credited with any effect on my continued good health. I am still riding my 1884 56" Columbia High Wheel Bicycle, and at our reunions on campus have toured the basin from the boathouse in a single shell every morning and am looking forward to doing the same at our 70th in 1998. Any more testimonials for longevity?

And now for class news: we are saddened by the belated report of the death of **Irl Sandidge, Jr.**, on July 25, 1989, at Austin, Texas.—**Ernest H. Knight**, secretary/president, Box 98, Raymond, ME 04071

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The 65th Reunion of the Class of 1929 was a great event and our thanks go to the Alumni/ae Association staff who helped plan the program and who took care of the mailings, dinners, and transportation.

Our first mailing was to over 225 of our class from whom we received 52 replies—8 saying they could attend, 7 who hoped to attend, and 29 who could not attend (20 of whom were widows).

The following attended: Mr. and Mrs. **Ralph Crosby**, Mr. and Mrs. **Arnold Conti**, Mr. and Mrs. **Karnig Dinjian**, Mr. and Mrs. **Robert Pride**, **Paul Baker**, **W. Gordon Bowie**, Mr. and Mrs. **Vincent Gardner**, and **Samuel Shaffer** and his friend, Iamgard Chow. Our dinner was served in the Penthouse of McCormick Hall overlooking the Charles River and the Boston skyline.

MIT requested that we have an election of class officers at the reunion. Our status at present is that our secretary, **Karnig Dinjian**, who has held the position for more years than we

can remember, has not been well. At present, Karnig does not feel that he can carry on but perhaps he will be able to in the future. So, for now, please continue sending your news to: Class Notes Editor, *Technology Review*, Class of 1929, MIT, W59-217, Cambridge, MA 02139.

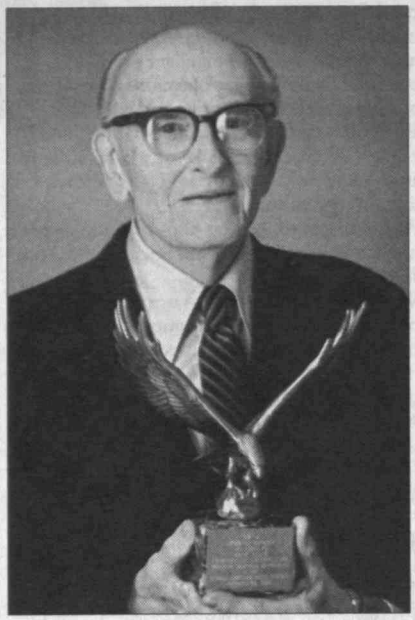
Our treasurer, **Joseph Speyer**, has had to resign after many years because he has a problem with his eyesight. Because of this situation and with no other class member in this area, I transferred our class account from Speyer's bank to mine, Belmont Savings Bank with V. F. Gardner and Eleanore D. Gardner as joint treasurers.

We are fortunate to have **Bill Bowie** as our class agent. He has done a remarkable job of obtaining donations from our classmates, and we thank him. The dinner group voted for me to continue as class president, and I accepted.

At this dinner we gave to each of our classmates a key chain with the MIT seal and a list of all those who responded to our invitation (with names, addresses, and phone numbers). If you want a copy, please write and I shall send it to you.

Our program was most interesting in that we were busy throughout the period but with time set aside to rest. On Thursday, June 2, we had a bus ride around Boston with a guide who was most knowledgeable. We then stopped at the Gardner Museum and had lunch and viewed the exhibits. In the evening we had dinner prior to going to Symphony Hall for the annual Pops concert. On Friday we attended a lecture at Kresge with the main speaker being I.M. Pei, '40, who gave a fascinating account of the addition he designed for the famous Louvre Museum in Paris. To all of us present, it was the most outstanding event of the reunion.

It was a pleasure to be able to be present at this reunion of the Class of 1929 in 1994 and I hope that we can meet in 1999. Save the date.—**Vincent F. "Jerry" Gardner**, 51 Hill Rd., Belmont, MA 02178



Jack Lane, '31, retired, 40-year Mobil employee, is the third person in 60 years to receive the Pioneer Trophy from The National Lubricating Grease Institute. NLGI recognizes "those who, through their farsightedness, enterprise, and innovation, pioneered significant and lasting improvements in the institute." Lane, who served on the NLGI board of directors from 1952 through 1986, chaired a committee to develop a lube-products rating program with the American Society for Testing and Materials. It set standards for such properties as viscosity and effective temperature ranges. Owners didn't know if the correct types of lubricants were being used for the chassis and wheel bearings of their cars, and Lane thought it would be helpful if owner's manuals could identify suitable lubricating greases by some means other than manufacturer's specifications or part number.

30 65th Reunion

In the August '94 Class Notes we reported that our Class President **Ed Pritchard** had resigned for health reasons. We have now received the sad news that Ed passed away on June 20. His wife, Blanche, who attended our 60th Reunion with him, has sent me a newsclip from the *Bourne Courier* that helpfully supplements my own records about him. In addition to the bachelor's degree he received with our class in 1930, he had both master's and doctoral degrees from MIT. After post-graduate work at the University of Gottingen and the University of Paris on a Swope Fellowship, he returned to MIT as a research associate in the Electrical Engineering Department for a number of years. He subsequently worked for Arma Corp. in Brooklyn, Tennessee-Eastman on the Manhattan Project in Oak Ridge, Sigma Instruments in Braintree, Mass., RCA Airborne Systems in Camden, N.J., and as general manager and vice-president of the Military Systems Division of Lockheed Electronics. He was listed in *American Men of Science* and *Who's Who in Engineering* and was a life member of IEEE. When Ed retired in 1977, the Pritchards moved to Pocasset on Cape Cod where Ed continued to work as a self-employed consultant for the Army, the Postal Service, and NASA among others. In recent years the Pritchards made annual trips to Europe where they visited their daughter Jane Jackling and her family who live in London. In addition to Blanche and Jane, Ed is survived by a son David who is a physics professor at MIT. Jane and David each have two sons.

As you know the 65th anniversary of our graduation is drawing near. Since the primary initiative for planning reunions is usually assumed by the class president, we have a bit of a problem to deal with. After I received the news of Ed's resignation, I had a number of telcons with **Yicka Herbert**, who was our 60th Reunion chairman and I am happy to report that, as noted below, some preliminary steps have been taken.(Parenthetically Yicka and Ed were lifelong friends; they met in kindergarten and their friendship continued through the years at MIT until Ed's death.)

In mid-July Louise and I spent a week at Belknap Point on Lake Winnipesaukee which is near **Reg Bisson**'s home in Laconia and across the lake from Yicka's Tuftonboro home. I had a brief telcon with Reg but was unable to arrange a meeting with him. However we did spend some time with Maryan and Yicka. One afternoon Yicka arranged for us to play duplicate bridge with a sizable group they play with in Wolfeboro. I may say that Louise and I were substantially outclassed; while the Herberts achieved a second place, we would have qualified for the booby prize if one had been offered. During our sojourn at the lake, specifically on July 15, Yicka and I drove down to Cambridge and met with **Jack Latham** and a member of the Alumni Association staff for a reunion planning session. Among other things it was agreed that a first letter concerning the reunion would be mailed some time in October. If this schedule is maintained, you will have received the reunion letter before these Notes are published.

We have a note from Win Hartford that begins, "Last year was a little too much!" It appears that in 1993 he gave the Colley Memorial Lecture for the American Wood Preservers and the environmental Keynote for the International Research Group on Wood Preservation, as well as making a speaking tour through Ohio for the American Chemical Society. "All of the above were directed to trying to introduce common sense into environmental legislation and the identification of the real villains!"

You may recall that in 1966, **Frank Hankins** was diagnosed as having Parkinson's disease and has been seriously handicapped since then. He and his wife live in Ft. Pierce, Fla. He reports that he is able to get from wheelchair to armchair and wheelchair to bed, but is not walking or exercising except for a few minutes daily on a stationary bicycle. He has found LevaDopa and Carbidopa to be of great help.

Bill Harris and his second wife, Edith, are "both well as expected." Although troubled to some extent by diabetes and impaired vision, he still drives. Their home base is in Wellesley but they also have a winter home in Florida and a summer home on Cape Cod that both his and his wife's family enjoy.

Merritt Hulett writes from Rockport, Tex., that he and his wife, Marjorie, "live a quiet life without much to report." Because of impaired eyesight and Parkinson's he has stopped driving but otherwise keeps active. He recalls that they moved to Texas in the fall of 1950 and for 20 years enjoyed wonderful fishing. However he stopped fishing five years ago and has now stopped most of his AARP tax aide work.

Margaret and **Paul Wang** have recently

moved to Coto de Caza, Calif.—"a gated community where numerous recreational facilities are offered to the residents of all ages." He reports that he is "still working full time," a statement that is increasingly rare among our classmates. At the time he wrote, he and Margaret were about to leave for a "much needed" cruise vacation to northern Europe because of the taxing job of house moving during the past months.—**Gordon K.Lister**, secretary, Apt.40, 5707 Williamsburg Landing Dr., Williamsburg, VA 23185

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Please send news for this column to:
Wyman P. Boynton, secretary
668 Middle St.
Portsmouth, NH 03801

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Jim Ritchey was honored with a Golden Rule Award given by JC Penney and the Metro United Way for his volunteer work at the University of Louisville Hospital. The citation reads, "For 13 years, averaging close to 60 hours per month, Jim Ritchey has been ministering to patients at the University of Louisville Hospital. Jim initiated his ministry in 1981, after perceiving a need in the presurgical area of the hospital. Five nights a week, Sunday through Thursday, he visits with patients and their families and listens to their hopes and fears. His goal is to help them prepare for what they will face the next day in surgery. It's a challenge for anyone to walk into a room of strangers and begin a conversation, especially at a time of crisis. Jim has bridged that gap to become a real comforting presence to the people he visits. He does this with a dedication unmatched by chaplains much younger than he. Jim's outreach to thousands of individuals over the years has been a model of the type of compassion our community needs. The JC Penney Golden Rule Award is in recognition of this tireless dedication and compassion." Jim recently celebrated an anniversary with his new wife, Rebecca.

Frank Chaplin writes us that he and his wife lead a quiet life in the home that they built for their retirement near the original Washington in North Carolina. . . . **Edmund McLaughlin**, our class agent, and I received a nice complimentary letter from **James M. Shackelford** for the work we do for our class. Thank you, James! Now, how about sending us a personal letter about your activities, your family, your thoughts on anything (maybe make it a model for some of our quiet classmates).

Albert O'Neill sent us an obituary of our classmate whom Albert recalls from school days. **Alexander J. Chaplik**, a retired procurement officer for the Air Force, died of heart failure at Boston University Medical Center in Boston. He was 87 and a resident of South Boston. Born in Lithuania, Chaplik came to America when he was 14 years old. In World War II, he served with the Navy as a lieutenant commander. After the war, Chaplik worked as a procurement officer for the Air Force until his retirement in 1965. He also had been an employee at the Gillette Co. plant in South Boston. Chaplik was a member of numerous Lithuanian-American civic organizations, including the Knights of Lithuania and the Lithuanian Alliance of America. He leaves his wife, Eleanora (Norkunas). . . . Albert spends a lot of time at home taking care of the needs of his wife, Helen.

Thomas Hannafin died April 14, 1994. His daughter, Robin Scott, writes, "We received the birthday card sent to my Dad. I am going to frame this card for my Dad and keep it always. How he loved MIT!". . . We learn that **Stewart A. Phillips**, 83, passed away in Providence, R.I., on March 1, 1994. Stewart retired, as engineer, from Textron in 1974. He was a member of Theta I fraternity. During World War II, he served as an officer in the U.S. Navy, where he was assistant supervisor of shipbuilding for the Second Naval District and stationed in Chicago. In 1936, he was president of the Rhode Island Engineering Society. For several years he was president and fundraiser for the Norton Visiting Nurses Association. For more than 40 years, Stewart was affiliated with the Church of Epiphany, Providence, where he was a lay reader. After his retirement, he was a regular member at Hamilton House on Angell Street. As an avocation, he traveled extensively in Europe photographing classical buildings, which he used as source material for lectures at elder care facilities throughout Rhode Island.

Rose and **Tom Weston** had a good summer traveling and visiting family. Perhaps the most interesting new experience for them was visiting Mackinac Island in Upper Michigan, where no cars are allowed. They took a taxi drawn by two horses. . . . Tom and **John Brown** are in touch with **Manley St. Dennis**. They are working on our attractive practical plan for a mini-reunion in Hawaii in 1995.—**Melvin Castleman**, secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Herbert E. "Herb" Grier sends a color photograph, "A Design for an Opera House" by John F. Vining, Class of 1892, which was submitted for his thesis. MIT has come a long way since the classical vogue and the École des Beaux Arts influence that was pursued up to the early 1930s at MIT. . . . Continuing in this vein, **I. Harry Summer** sends a write-up on the new Seiji Ozawa Hall at Tanglewood. Seating 1,180 at a cost of $9.7 million, it was built primarily as a performance and recording facility quite unlike the 1892 design for an Opera House mentioned above. Judging from the *Christian Science Monitor* article of June 30, 1994, it should be acoustically perfect because of the somewhat overembellished use of wood everywhere save for the lighting fixtures. . . . **Wilbur B. "Bill" Huston** writes to let me know about "Treasures from Heaven," a collection of 90 illuminated manuscripts from the hands of Armenian monks living from the 10th to the 18th centuries. The public exhibition will be over when you read this, however, I did see a portion of these manuscripts at the James Pierpont Morgan Library early in 1934. These manuscripts demonstrate the high degree to which Armenia, the oldest and easternmost Christian nation, had evolved as an independent cultural entity.

Paul M. Gerhard passed on May 30, 1985, as reported by his wife, née Florence M. Kerrigan, whom he married in 1943. After MIT,

ClassNotes

Paul seems to have spent 10 years as a single person on top of Mt. Washington working for the Budd Co. and claiming to have broadcast there from the first commercial FM station anywhere. (Interestingly, the highest surface wind speed ever recorded of 231 mph was recorded on Mt. Washington April 12, 1934.) Apparently thereafter he married and became an engineer for the Yankee Network of Boston. His interests were many which now we call "environmental," and his hobbies mostly associated with the outdoors.

Thomas Francis Twomey passed away March 25, 1994. His entire career of 40 years was with the E.I. du Pont de Nemours, from which he retired in 1975. His affiliations were with Council 247, Knights of Columbus, Professional Engineers of New York, American Chemical Society, and the American Institute of Chemical Engineers. His survivors include his wife, née Marion Kranhold, a son, and two daughters, a sister, and four grandchildren.

Most unexpectedly, I have been apprised of the passing of our class treasurer, **Charles Price Britton II**, on July 6, 1994. The sources of this quite shocking news also make for a bit of drama since one of the two reports comes from **LeBurton Webster**, who served as class treasurer for three years just preceding Charlie Britton. As I have learned, Burt Webster has been one of the most active members of our class, particularly in fund-raising. Charles was a Course XV, business and engineering administration graduate, with later education at Yale University. Kent School at Kent, Conn., not only prepared Charles for MIT but has been named to receive memorial contributions. At MIT, Charles put on many hats: manager of varsity boxing, class treasurer (we might have known where his business acumen began), Field Day usher, and marshal his last year. Charles is quoted as saying that he began luckily with the Hartford Fire Insurance Co. in 1933 until called to duty at the U.S. Navy Yard, Boston, in 1943, serving there as a lieutenant for the duration of World War II. Back in Hartford, Conn., an enterprising insurance company was begun under the name of Goodwin, Loomis and Britton from which Charles retired as president in 1978. Charles' first wife, née Frances Wood, died in 1972. Jane Yeomans Tyler is Charles' surviving wife along with three children from his first marriage and four stepchildren from the second marriage. There is a wonderful total of 19 grandchildren and even two great-grandchildren. Our condolences to all the Brittons.

Coming back to LeBurton Webster, who writes (and it had to be quite an effort since he is virtually blind): "Reading, driving, and travel are a thing of the past—happy memories. Talking books and my darling wife, Elizabeth, keep me happy." Now I understand the telegram Burt sent to our 60th Reunion saying he would have liked to be with us but that he was "incapacitated." You see, Burt was on that 60th Reunion Committee serving as best he could. Just great, Burt!

Wilber Huston is running about the country attending *five* different family reunions, one of which is wife Dorothy's North Carolina fami-

ly reunion over 50 years since its origin. A college reunion of Dorothy's scheduled for late July must by why I couldn't reach him for the past three weeks.

I would like to receive photographs of any of you and yours as well as anything else in writing that may be of interest to the rest of us. The 65th Reunion Classbook might have some use for these photos. Let's communicate.—**Berj Tashjian**, secretary, 1245 Briarwood Ln., Northbrook, IL 60062, (708) 272-8683

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This month's mail brings more bad news. We have word of the death of **Frank Dowling** on March 12. He spent his freshman year with us before transferring to Columbia. Our sympathy to his wife, Elizabeth. . . . **John Brunner** died last March 6. While at Tech, John was president of the Civil Engineering Society and editor-in-chief of *Benchmark*. He was staff engineer for Albert Ramond Associates, Management and Industrial Consultants, in Chicago. He is survived by his five children—Charles, John, Katherine Gunwalberg, Barbara Codero, and Hazel Shaffler—to whom the Class offers sincerest condolences. . . . **Charles Gamble** died December 18, 1993. Charles was active for four years in Dramashop, ending as general manager his senior year. He also served on the Institute Committee. He worked for the Alabama Gas Co., in Birmingham, and became their executive VP and CEO. He also served as chairman of the National Standards Committee for Gas Appliances and chaired the Research Program of the American Gas Association. Our sincerest condolences to his family.

George Westefeld died last April 16. He is survived by his wife, Ruth, a son, John, a daughter, Ellen Boykin, and three grandchildren. Our condolences to them all. I remember George well from his undergraduate days. I was in the same course and also participated in many extracurricular activities together. He was in Tech Show, played in a jazz orchestra, was a skillful music arranger, was on the Swimming Team and Crew, and was a member of Delta Upsilon. George spent his entire working career with Anaconda-American Brass Co., in Washington, D.C., Torrington, and Waterbury, Conn. He was an engineering manager when he retired in 1972. He also spent considerable time on assignments in Mexico and Brazil. He was very active in community affairs after retirement until Parkinson's forced his entering the Cheshire Convalescent Center.

A recent letter from Anita Rogowski tells us that on May 19 **Al Rogowski** had to be taken by rescue squad to the hospital where he underwent five hours of surgery. Diagnosis: a cerebral vascular brain hemorrhage. He was making good progress until June 2, when he suffered a stroke. He was then transferred to a rehab hospital where he received extensive physical therapy. He is making good progress, and hopefully by the time you read this, he will be home with Anita. Al was a faithful attendant at all our reunions. He was sorely missed at our 60th. All his friends wish him a complete recovery!

Gudron and **George Gahm** were guests of Mollie and **Carl Wilson** for a great weekend at Lake Chargoggagoggmanchaugagoggchabunagungamong. This is where Carl spent his youth. The translation of the name is the home of the longknives at the pleasant waters that are the boundary lines of the tribes.

To the Editor:

"Henry Regency" in Aug./Sept. must be Henry Regnery. I remember visiting Henry in his room on Beacon St., as a freshman. He was practicing on his cello.

Much later, during a canvass, he kindly said he remembered me, and sent me a copy of his "Memoirs of a Dissident Publisher," asking me to send it on to the MIT Library when through. After browsing a while, I mailed it there.

This book is so full of reminiscences of interesting people, plus Henry's astute comments, that I was happy to find another copy. It's here on my desk.

Sincerely,
Charles A. Wesley, '34
Wilmington, N.C.

The original name did not contain the first half, but was added after Samuel Slater traded two muskets for all the land he could pace off between sunrise and sunset. George was treated for prostate cancer two years ago and has been well since. The Gahms attended the wedding of one of Gudron's grandsons at Salt Lake City in July. Their grandson attended Salt Lake City University, fell in love with Utah and Salt Lake, and his bride to be! Shortly thereafter the Gahms left for Denmark to celebrate Gudron's 75th birthday, including a luncheon at Tivoli where the Pittsburgh Symphony Orchestra was playing on tour. Another grandson, David, is the principal bassoonist. Gudron still has family and children living in Denmark, and her birthday was attended by both their American and Danish families.

John Hrones sends a note and a clipping from the Jaffrey newspaper with an article about **Bissell Alderman**, '35. Bissell came to MIT with us in 1930, but his fifth year in architecture produced the '35 designation. Bissell and his wife, Mary, live in Jaffrey, N.H., year-round. John sees him regularly at the Jaffrey Men's Club luncheon. Bissell has designed several town parks. At a recent naming of a new park, the local selectwoman informed the crowd that the park's designer had been overruled—the name would be Alderman Park.

Today's mail brings a letter from Warren Seamans, curator of the MIT Museum. Mitsi she is! By acclamation, Annette Asch's suggestion (see October class column) has been accepted as the official name of the policewoman who was at the wheel of "The Cruiser on the Dome." He concludes with the comment that the response of visitors has accelerated plans to update the "Crazy After Calculus" exhibit into an MIT "Hall of Hacks." It will be ready the next time you visit the museum.

Annette and **Ed Asch** plan to contact you for news for our class column. Ed says we went too long without '34 news in the *Review*. He is determined to seek out anything, newsworthy or not, from all of you. Ed also sent along a montage of pictures that he took at the 60th, mostly dealing with the "survivors" of the MIT athletic teams of the 1930–34 era.

Winifred and **Ed Taylor** again had a relaxing and sunny five months (November–March) at San Miguel Allende, State of Guanajuato, Mexico. Win joined a painting group for three mornings a week, while Ed was well occupied as a volunteer in the excellent library. Fresh vegetables and fruits from the nearby markets. No telephone, radio, TV, or car. A great contrast with the State of Maine, where the Taylors live.

As I sit here typing these notes on a hot August day, cooled by a lovely breeze off the lake, I realize that by the time you read this, Mollie and I will be in Coronado. Mail from December 1 to March 30 should be sent to: 1820 Avenida del Mundo, #309, Coronado, CA 92118-3014. The telephone is (619) 435-3712, if you would like to call, particularly if you are in the area. We are just 200 yards from the Hotel del Coronado. Have a great winter!—**Carl H. Wilson**, secretary, 48 Druid Hill Rd., Newton, MA 02161-2023, (617) 527-7088

35 60th Reunion

Lester (Les) Brooks writes from his home in Rockmart, Ga., that they are 50–60 miles north of the leading edge of the flood areas. "We are still fine but do spend more time making sure we stay healthy. If we have any energy left over from everyday living, we use it to dispose of unsolicited mail. Although the Caribbean is our favorite vacation area, we've begun to notice that we're the oldest couple on the plane, or in the hotel, or on the beach. We'll keep traveling as long as we can walk, but it will be in low, low gear." . . . **Jim Eng**

'34 Athletes Reunite
for updated team photographs at their 60th reunion. (From left) Hockey: John Hrones, Tom Burton, Roger Williams, and John Borger. Football: Roger Williams, Jack Carey, Carl Wilson, John Borger, and Ed Asch. Crew: Larry Stein, Russell Hastings, Tom Burton, Robert Roulston, Ed Cantor, Carl Wilson, and John Newbegin.

called Les from San Francisco, mostly curious about plans for next June's 60th Reunion. Les told him he would go if he was still around, but Ellen had already said she would have to take a raincheck; walking is painful for her. Les said he hadn't played golf for about a month and had a good garden this year with some rain. He had a cystoscopy that made him pretty uncomfortable for a couple of weeks but is okay now.

Leo M. Beckwith writes from his Florida home, "Everything's fine other than a mild stroke I suffered in June 1993. I'm getting along pretty well with the help of a cane, and even play a few holes of golf once a week. Marylyn and I still enjoy six months in Florida and six months in Swampscott, Mass. Looking forward to our 60th and seeing you and the fellows."

In mid-June I learned the hard way that I am too old to be delivering newspapers and magazines even if it is only one day a week. I began before 8:00 a.m., took a short break at noon, then, at about 3:15 p.m., I blacked out crossing the street and collapsed against a concrete curb. I came to with my face a bloody mess and driving my car. I drove home, washed my face, called the paper company, and proceeded to drive 15 miles to my Urgent Care clinic. After giving me seven stitches and some strong talk about the dangers of driving with a concussion, I was ambulanced to Sharp Memorial, had a CATSCAN and MRI, and was sent home two days later, kindness of a driver/friend, with the warning, 'No driving for six months.' Thanks to many friends (including our Class President **John F. Taplin**), much walking, and being allowed to drive after six weeks, I lived through a Californian's worst situation: no car. Six weeks because the DMV found I had never blacked out before and didn't expect I would be trying to deliver papers during 90-degree days again. I am back to walking and playing a par 3 course each late Friday afternoon. Latest score, 68!

My Chi Phi brothers **Alfred E. MacAdam, Charles H. Schauer**, and **Eugene F. Schwarzenbek** owe me *first* letters since graduation to bring us all up to date. Please write now to—**Allan Q. Mowatt**, secretary, 715 N. Broadway, #257, Escondido, CA 92025

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Traveling to New Jersey (grandchildren's graduations) and to old digs in Vermont, I saw **W. Bennett Sharp** (Course XV), **James Stewart** (Course II), and **Frederick Watson** (Course V). Ben started at the Institute two years before us, dropped out twice to replenish the exchequer, and graduated with his younger brother, **John Sharp**. Ben did the GE test course in Fort Wayne, Ind., and Schenectady, N.Y., working at the latter, then taught at Newark College of Engineering while attending Columbia University Graduate School. In World War II, he did three years in the Navy, planning rocket production. Thus equipped for industrial engineering, he managed multimillion-dollar projects for CBS, J.C. Penney, Federal Pacific Electric, and Lockwood Greene Engineers, "from a gleam in the bosses' eyes to bigger and better plants, complete and operating." Ben's credo: "If you want a job, don't rely on agencies. Do your homework first on sources available in libraries, and go personally to a prospect, armed with extensive knowledge of the company."

Jim Stewart is retired from Adams Division of Ekco Co. in Holyoke, Mass., producers of injection and compression moldings. At MIT he was track and cross-country and is still in good shape. In World War II with the Army Air Force, he was lieutenant-colonel in command of air-base squadrons in the South Pacific, adding tail guns to early B-17s to help the "Flying Fortress" image. He and wife Winifred have three sons: one a teacher, another in biomedics, and the third in quality control. So the genes carry over, and Jim sends pertinent articles from *Technology Review* to each son. Jim was struck with the April issue's "The Side of the Angels—MIT and the Overlap Suit" (brought by the Justice Department) and gave the report to a retired admissions officer of Mount Holyoke College. She sent it to a friend in England, who has arranged a visit to the Institute for first-hand details of the intercollegiate arrangement, effectively sustained in the appellate court.

Fred Watson came to Tech with a master's from Dartmouth and got a PhD in chemistry. His 37-year career with Du Pont included research, export sales, and management in both, with the latter taking him to 41 countries. My luncheon partners on last year's three-city trip—**Howard Turner, Leonard Chandler**, and **Bernard Sturgis** (October '93 Notes)—were all colleagues at Wilmington, as was **John Roberts**. At 85, Fred still swims regularly and was leaving shortly on a fishing trip to Canada. As we sat on his deck overlooking Lake Spofford, he recalled **Bob Woodward**, the 1965 Nobel laureate in chemistry (Nov/Dec '93 Notes): "An almost self-taught genius who could pass exams without attending classes or lectures (and took as many as 15 subjects at one time), but who carried it with sometimes unique humor and grace." With an ocean fishing group off the North Shore in 1935, Bob rested prone in a towed dory, unnoticed, on the trip back. Fishing had been good, and some students cleaned and tried landing fish heads in the dory. One of Fred's heads landed on Bob's nose, bloodying it. He sputtered, yet with no ill humor drove Fred home. Fred's wife, Annette, died in 1990.

Along the way I stopped to see President **Alice Kimball** and met visiting daughter Prudence and her husband, David Phillips (no relation), who later came to Santa Fe in August for the opera and a visit. Alice's four children and their families threw an early 80th-birthday party for her in June, with over 100 Hartland friends and neighbors attending. On the actual date, October 21, she would be heading for South America to view the total eclipse of the sun.

Also along the way, **Pat Patterson** and Marian were home in Pleasantville, N.Y., briefly between appointments with doctor and dentist. Marian is not well, and Pat asked to be replaced as assistant secretary. Alice and I would prefer to supplement his knowledge of, and acquaintance with, the class by adding assistants. So will those in a position to correspond and/or telephone please step forward?

Roman Ortynsky, with his file of *Techniques*, has been a source of information several times and is glad to continue, but we could use several more helpers in various parts of the country. Along with some information on Bob Woodward, Ro sent a map of Peachtree City, Ga., and the July flood—a squeaker for him and Bernadette. The stream feeding Lake Peachtree came within one inch of its bank at the rear of their property and flooded the golf course on the opposite bank. A large area about one mile away was evacuated. . . . For a chuckle on longevity, read the Class of 1925 Notes in the Aug/Sept issue—a ditty written by George Wales, '89 (1889, that is).

Cheers for the life of **Joseph Chenette**, who was the man of his home from age 5! Joe's father, a pharmacist, died in the 1918 flu epidemic, and at an early age Joe worked to help

support himself and his mother. He managed through two-and-a-half years at MIT when he became one of many Great Depression causalities in the class. Yet, building on the Institute's Course I basic regimen, he continued with self-education and made a career in 42 years of engineering management with Brewster Co. of Hackensack, N.J. One of many large projects was the Meadowlands Sports Complex. Joe died at home June 22 of untreatable lung cancer, discovered less than three months earlier. In the obituary, memorials were directed to MIT, Rm. 200, 238 Main St., Cambridge, 02142. His widow, Madeleine, also sent a poem written by one of their five daughters for his 81st birthday, June 12, and a eulogy delivered by a son-in-law. Both convey the spirit of a gentleman of love and devotion—to his family and grandchildren, his work, and his God. Would that we could all die with such dignity and grace.—**Frank L. Phillips**, secretary, 1105 Calle Catalina, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Not as much news as I would like to report, but am grateful to have heard from the following.

Walt Wojtczak writes, "As you know, June and I split our time between Florida and New Hampshire, except for two or three trips yearly to California to see our second crop of grandsons, Scott (26 months) and Adam (8 months). We don't travel anymore. I stay active with church, MIT Club of Southwest Florida, play tennis two or three times a week, and have a small garden—vegetables and flowers. We are okay healthwise, considering, but we both have had some problems. We are looking ahead to our 60th, Lord willing. Glad Rose [Thorson] is doing well after the knee replacement. Have friends with one knee done and it is not easy." (Note: Rose had both knees replaced on June 2 at Mass. General. Now, the end of July, she is doing fine, walking around the house without cane or crutches, driving her car, and best of all, doing the cooking, which is a relief to both of us!)

Hard to believe that Martha and **Joe Smedile** have been in their Florida house for over 13 years and "busy with repairs and replacements. Martha is undergoing therapy with a new therapist with the hope of improving her mobility." . . . **Bob Glancy** keeps himself pretty busy. "I did my twelfth year of tax counselling under the AARP program. Am active in local Golden K (Kiwanis) and will serve next year as first vice-president. Also teach a small class of Seniors Sunday School. On a sadder note, we lost my younger daughter's husband to a fast-moving cancer on May 14 at the age of 46. He was president of Migh Mountain Diesel Co. I spend lots of time hacking with computer games and graphics. Second cataract operation still pending. Some months ago I had a pleasant surprise call from **Tom Hallenbeck**, who is doing okay in spite of his handicap."

And from another busy classmate, **Jim Ewell**, got this welcome letter. "The July *Tech Review* with your two-and-a-half columns of notes arrived today and reminded me that I have been less than helpful to you. Thank you for your years of dedicated reporting! To make amends, here are a few personal notes. Since retiring as a senior VP and member of the board of Procter & Gamble in 1979, there have been a number of civic activities to keep me busy. As a board member and then president of the Cincinnati Symphony Orchestra, I did the feasibility studies and then oversaw the construction of Riverbend, the symphony's summer home on the banks of the Ohio River. Next month we celebrate its tenth anniversary. It has been most successful, both artistically and financially. The orchestra performs two nights a week, and the other nights we present name acts. Last December an expansion project of over $100 million for our Children's Hospital, which I also oversaw, was completed ahead of schedule and under budget. During the period, I was also president of the Cincinnati Nature Center, which also had a building expansion in which I was involved. My four children, all married, have produced six grandchildren, four of whom are now in college. My wife, Bette, and I have covered quite a bit of the globe over the years and have many plans for the future." Jim, thanks for your nice letter bringing us up-to-date on your activities. I hope it will spur other classmates to write.

With sorrow we report the death of Professor **Leo B. Moore** on August 1, 1993, after a long illness. Leo became a professor of management at the Alfred P. Sloan School of Management. He was also an authority on industrial standards engineering and organizational and personnel management. He served as a lieutenant-colonel in Army Intelligence in England in World War II. In addition to his wife, Christina, he is survived by five children—Thomas, Charles, John, Richard, and Susan. We extend our sympathy to the Moore family.—**Robert H. Thorson**, secretary, 66 Swan Rd., Winchester, MA 01890; **Leonard A. Seder**, assistant secretary, 1010 Waltham St., #342B, Lexington, MA 02173

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Class Agent **Don Severance** provides a *Wall Street Journal* article on the new 1,400 space garage at Post Office Square. "Call it Garage Mahal; It Has Greenery on the Top, Mozart in the Elevators—and Boston Just Loves It." The article covers the design and financing in detail and credits Boston developer **Norman Levanthal** with organizing Friends of Post Office Square to try to rid the neighborhood of a crumbling three story parking facility.

Marie and **Paul O'Connell** write that they enjoyed the varied fruit trees, pineapple plantations, and sugar groves as well as the beaches on Maui before viewing the tumbling streams, spectacular valleys, and Napoli coastline of Kauai from a helicopter. Before returning to the mainland they toured Oahu and were particularly impressed by the Polynesian Cultural Center with its separate villages representative of Fiji, Tonga, Tahiti, Samoa, New Zealand, and others. Their stay at the Hale Koa military hotel on Fort De Russey gave them a view of Diamond Head and a short walk to Waikiki Beach. They recommend these lovely Hawaiian Islands to everyone. Aloha!

A telephone call from an attorney advised of

the death on April 22 of **Walter F. Kaufman** who graduated in mechanical engineering and lived in Selingsgrove, Pa. Since his wife predeceased him we are having difficulty getting any additional information.

After having been advised by the financial aid office that a large part of his MIT grants for the 1993–94 and 1994–95 academic years were made possible by income from the Class of 1938 Scholarship Fund, Richard E. Domonkos, '95, wrote to our Class President **Fred Kolb** extending his gratitude and relating the importance of the award. He reviewed the problems of his early life and his family circumstances including having been born in New Jersey but raised in Colombia, South America, returning to the United States in 1981. He graduated as valedictorian of a class of 391 at Edison, N.J., High School and has worked each college summer at Minnesota Mining and Metallurgical operations in St. Paul, Minn. He concludes his letter, "I have taken advantage of all the opportunities that MIT offers its students. I am studying mechanical engineering and have two terms left to graduate. Without awards like the Class of 1938 Scholarship Fund, students like myself would never have the chance to attend MIT and realize their dreams. I owe thanks to everyone who has helped me reach the point at which I stand today."—**Paul R. Des Jardins**, secretary, 6241 Old Dominion Dr., Apt. 310, McLean, VA 22101-4807, (703) 534-4813, **Gretchen Birge**, assistant secretary, 233 Carroll St., Apt. 202, Sunnyvale, CA 94086-6264, (408) 736-5011

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Jim Barton and Mary planned to visit friends in Massachusetts and relatives in New Hampshire after our 55th Class Reunion. However, a yielded suture interrupted, but fortunately they were near the famed Lahey Clinic where remedy was made. Classmates who called there included **Fred Grant** and Ginny, **Manning Morrill** and Connie, and **Fred Schaller** and Anne. Those who phoned from the Northwest included **John Alexander** and Nancy, **Bob Withington** and Betsy, **Hans Bebie** and Austie, and Hilda and me. On the flight from Boston to Seattle, the Northwest Airlines pilot thoughtfully detoured over southern Canada to avoid traditional summer thunderstorm turbulences. Now Jim is convalescing in the rehabilitation portion of the University Hospital. Jim and Mary report they have been overwhelmed by the number of get-well messages from classmates. Thirty-niners who would like to increase the overwhelming may mail messages directly to 4038 Hunts Point Dr., Bellevue, WA 98004, or phone (206) 454-1995.

Gus Hunicke recalls pleasant voyages with classmates on his *Trinket* off Edgartown, Mass. Gus writes: "I'm very, very happy with my wonderful three kids, their spouses, and my grandchildren, all of whom live nearby. I gave up smoking and drinking and am now recommending that to others." For details, write Gus at 44 Banbury Crossing, Old Saybrook, CT 06475.

Len Mautner and Marguerite are active to and from their Pacific Pallisades (Calif.) home.

ClassNotes

On the day I phoned, they had golfed and swam. And several evenings before, they sat under the stars in the Hollywood Bowl, listening to a concert by the Budapest Symphony Orchestra. At the 55th Reunion, Len accepted the invitation to serve '39ers as class estate secretary. He is available to consult on request.

James T. Blakistone succeeded in east coast aircraft corporation management early in his career, then migrated to Del Mar, Calif., where he established a new company to present Little Theater Plays. The producer is Mrs. Blakistone. Now in its thirteenth season, the Blakistone group continues successfully, having built and paid for its specially designed theater, having no debt, and bringing quality entertainment to Del Mar and adjacent communities. Between seasons, JT does backpack hiking in the Sierras, and his hiking conquests include Mt. Whitney.

Seymour Sheinkopf and Sylvia parked their silver bullet trailer home at Wolfeboro Compound, N.H., to enjoy summer away from mid-Atlantic heat and humidity. Seymour has a new laptop. It weighs 6 pounds and holds 4 MB of RAM and 200 MB on its hard drive. At summer's end, the Sheinkopfs plan to visit **Aaron White** and Edith and **Mike Norman** and Grace. After returning to Burtonsville, Md., they expect to consult **Sid Silber** and

Jean, **Ernie Kaswell** and Yolande, **Art Zeldin** and Helen, and **Bill Wingard** and Anita about a mini-reunion.

Smitty Curtis and Muriel major in tennis and sailing on Cape Cod. Smitty mentions a rumor that the MIT Alumni/ae Club on the Cape is the nation's largest. I have no statistics about club sizes, but Smitty's rumor is probably confirmable. According to the 1994 MIT Alumni/ae Register, living MIT alumni/ae in three states in 1993 numbered 17,188 in Massachusetts, 11,048 in California, and 6,311 in New York. USA total was 73,813, plus 20,000 abroad.

George Cremer and partners are developing process and equipment to optimize combustion in, and heat utilization and waste gas quality from, internal combustion engines. . . . **Jack Hamilton** and Joan were drawn in 1994 to the 50th reunion of Joan's class at Miami University in Oxford, Ohio. Joan was on the committee, which enabled Jack to have an easy ride alongside. During January-March they expect to miss Chillicothe, Ohio, snows by wintering in Naples, Fla.

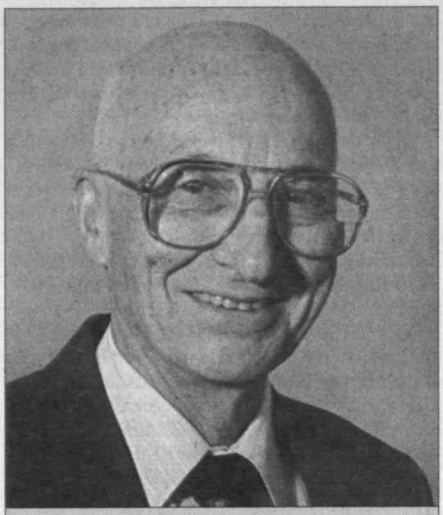
John Alexander and Nancy are motor cruising this summer on Puget Sound, Wash. They will join Hilda and me for a concert sponsored by the Tacoma Barbershoppers. Featured stars will include the past National Champion Quartet and the current Evergreen District Champion Quartet. Neither to be featured nor heard from will be two '39er basses who no longer sing on the risers. . . . **Bob Saunders** and Sybil acquired a new word processor and are in the process of discovering whether it is user-friendly.

We are saddened to report the death on January 22 of **Robert L. Van Nice,** master in architecture. His career included work as senior research associate at Dumbarton Oaks Trustees, Harvard University, Washington, D.C.—**Hal Seykota,** secretary, 2853 Claremont Dr., Tacoma, WA 98407

40 55th Reunion

My request for locations of missing classmates has borne fruit. **Scott Brodie** sends a note from Gulf Breeze, Fla., with the address of **Albert Ericson,** and Scott also mentions **Robert Dobson** and **Bonner Hoffman** but only to say that they are alive and well and were fellow classmates in Group #18. . . . **Richard McKay** sends **Al Ericson**'s address and adds that he and Al were close friends at the Institute. They have maintained contact ever since. Dick has a daughter in Falls Church, Va., and occasionally when he visits his daughter he also sees Al.

I also had a telephone call from **Alvin Guttag** to say that **Robert De Arellano y Cano** had been killed by Fidel Castro. Al had no further information on Bob's death. Al said he wasn't sure whether he would be able to attend the entire reunion next June, as his son will be graduating from Harvard Divinity School. This son followed in his father's footsteps, studying chemistry, and thereafter embarking on a career as a patent lawyer. But he then had a "calling," and embarked on a new career path. Al is very happy in his retirement community, and continues to run, participating in many road races. He acknowledges that he has slowed down considerably over the years.



HAVE YOU WRITTEN TO THIS MAN LATELY?

Richard Gladstone, '40
Class Secretary

In the expectation of more responses with locations of other class members, the list continues: **George Miller, Robert T. Monrad, George R. Mounce, William S. Mounce, David L. Mowrer, Jr., Ernesto Murillo-Fernandez, Yoneo Nakayama, Borge P.E. Nissen, Angelo R.J. Orlandella, Harold B. Palmer, Walter M. Palmer, Robert A. Parent, William G. Peck, Jesus C. Perlas.** Please do write or call if you have information on any of these classmates.

Joseph B. Wiley, Jr., sends a note from Far Hills, N.J., enclosing a copy of a letter from Governor Christine Todd Whitman. She writes, "I am pleased to advise you that the Senate has confirmed your appointment as a member of the Hazardous Waste Siting Facilities Siting Commission. Accordingly, I hereby appoint you to this commission. I am confident that you will fulfill the duties and responsibilities of this position with competence and integrity. I am pleased to have you join me in working to achieve the best New Jersey for all our citizens. I wish you the best of luck in your endeavors with this commission."

In 1993-94, Mrs. **David T. Morgenthaler,** who serves on the Development Committee, accepted an invitation to become a member of the Council for the Arts at MIT. The Council for the Arts is a volunteer group of alumni/ae and friends established to support the visual, literary, and performing arts. Members are appointed to three-year terms and serve as advocates and advisors to MIT's Associate Provost of the Arts. The Council's grants program, without parallel at any college or university nationwide, has awarded over $800,000 since 1974 to more than 700 arts projects created by MIT students, staff, and faculty.

A copy of a letter from **Samuel Card** to Class President **Norman Klivans** was sent to me and other class officers. Sam discusses the 55th reunion, the committee, the Technology Day luncheon, and the possibility of a class gift. By the time you read this, the last general mailing will have gone out, and the next one will be to those who have expressed a continuing interest in attending the reunion.

PHOTO: L. BARRY HETHERINGTON

I look forward to your letters and phone calls.—**Richard E. Gladstone**, secretary, 250 Hammond Pond Pkwy., Chestnut Hill, MA 02167, (617) 969-5161

ClassNotes

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I learned that **Hugh Kenneth Spaulding** passed away on May 20, 1994, from his wife Gwendolyn, of Huntington, N.Y. Ken was a member of Course III and the Beta Chapter of Theta Chi at MIT. He was also active in the Nautical Association, Hobby Shop, and swimming. He returned to MIT for a Senior Executive Program at the Sloan School in 1957.

Ken joined the American Smelting and Refining Co. shortly after graduation as a junior metallurgist at Perth Amboy, N.J., in the tin and lead department. He advanced through several positions before being named Perth Amboy plant manager in 1968.

He was appointed project manager for the Amarillo (Texas) Copper Refinery in 1973, when the Amarillo facility began construction. He became plant manager when the refinery began its first production in 1975, a position he continued until retiring in 1983.

Ken was a member of the American Institute of Mining and Metallurgical and Petroleum Engineers, a former director of the New Jersey State Chamber of Commerce, a director of the Amarillo Chamber of Commerce, a member of the board of trustees of the Amarillo Foundation for Health and Science and Education Inc., a member of the Employee Education Committee of the Texas Division of the American Cancer Society, and served on the United Way Board.

All members of the class express their sympathy to his wife Gwendolyn, four sons, two daughters, and thirteen grandchildren.

Chet Hasert tells me that I am at least partially reponsible for low news months by not submitting items of my own. Here follows his suggestion for such an emergency: "The photo of the MIT '41ers" at the Russian Embassy that appeared in *Technology Review*, February 1994, left untold several interesting past experiences of Russian-American joint ventures in which those pictured had participated. Chet fills us in with the following: "Three of us had acquired a smattering of the Russian language, and had great fun practicing with the Embassy Staff.

"Your secretary, **Charlie King**, had been an important player in the Apollo-Soyuz Test Project, the joint-program to link up American and Russian Spacecraft in space in 1975. As director of engineering for the U.S. side, he studied Russian for three and a half years to facilitate his meetings with Russian counterparts.

"**Bob (Wilson) Blake** was an invited guest to the USSR of the then Soviets as a part of a joint team studying construction methods for large buildings in both countries. Bob was then director of building research in the U.S. Department of Health, Education, and Welfare, and was involved because of the large HEW hospital building program. At the recent Embassy party, Bob wore his laminated plastic name tag from his trip, with his name in both English and Cyrillic (Russian) letters.

"I had worked with Soviet air force officers who were at Wright Field overseeing procurement of Bell P-39 fighters, used so effectively by the Soviets during World War II. Later Chet was present at the historic joining of the Soviet and American troops at Torgau, on the Elbe River, and drank a vodka or two with Russian troops.

"More recently, in 1988, I was with a medical group in the old Soviet states of Georgia, Armenia, and Azerbaijan studying the reputed longevity of the residents of this region of the Caucuses. Some attribute their long life to the yogurt, but I'm inclined to credit the Armenian brandy, and cite Winston Churchill's preference and frequent medication with this special brandy.

"And congratulations to Charlie King on the addition of a fifth PhD to the family roster (three sons and two daughters-in-law). Andy, whom many of you met at our 50th while he was studying at MIT, just received a PhD in management from the Sloan School and is now teaching in the management school at New York University."

The Class Notes editors at *Technology Review* have been encouraging us to include more pictures. Black and whites are best but clear color photos are fine. Please send in your vacation and other news and photos.—**Charles H. King, Jr.**, secretary, 7509 Sebago Rd., Bethesda MD, 20817, (301) 229-4459

1921–1994

KENNETH R. WADLEIGH, '43

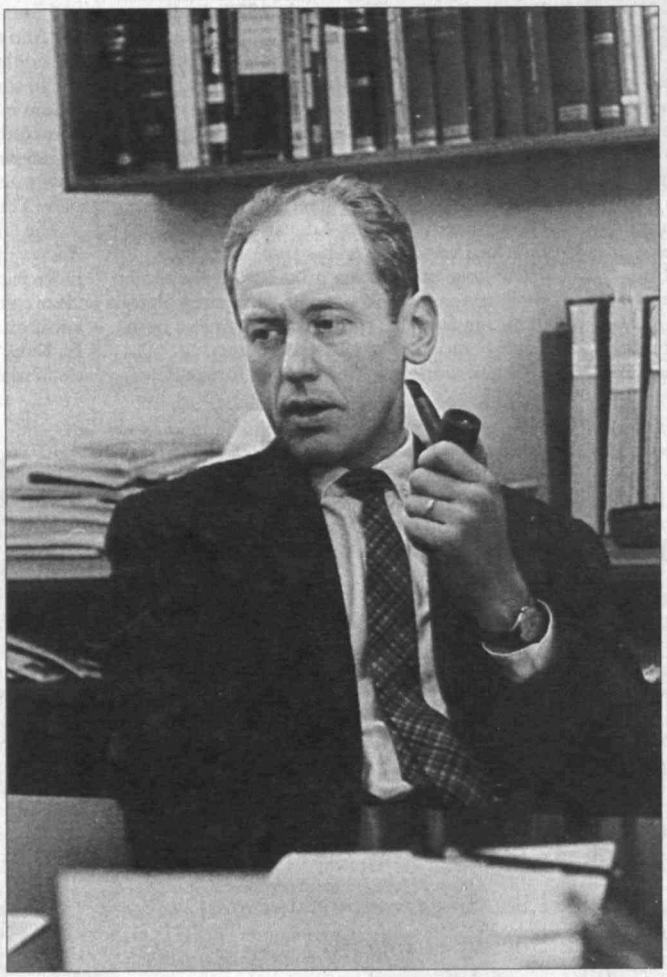
Dean for the '60s, Architect of MIT Medical

From his first year as an MIT undergraduate through his last as an MIT vice-president, Kenneth R. Wadleigh, '43, SM '43, ScD '53, demonstrated the technical skills, energy, resolution, and career mobility that are prototypical of MIT. He died on July 21 in the MIT infirmary after a short illness, leaving a record of achievement and service.

Soon after entering MIT in September 1939, Wadleigh was admitted to the five-year honors program in mechanical engineering that lead to bachelor's and master's degrees. The program was accelerated with the outbreak of World War II, so he emerged in 1943 with two degrees—and an ROTC commission as an ensign.

After military service in the Pacific and for the National Advisory Committee on Aeronautics in California, Wadleigh returned to the Institute as a graduate student and an instructor in mechanical engineering in 1946. He was promoted to assistant professor in 1949, and four years later he finished his doctorate in thermodynamics and simultaneously received the coveted Goodwin Medal for oustanding teaching. He continued to move up through the professorial ranks, and in 1961 President Julius A. Stratton, '23, appointed him dean for student affairs.

During his 15 years of teaching, Wadleigh contributed to research in thermodynamics and heat/energy transfer systems; directed the transformation of the department's steam laboratory into a modern steam-power teaching facility; put in place a new laboratory subject in heat, power, and internal-combustion engines; and played a major role in devising the Institute's first engineering project laboratory subject and the facilities in which to conduct it.



Stratton, seeking to capitalize on Wadleigh's recognized success in working with students, realized that moving him into the dean's office would deprive the School of Engineering of one of its stars. Faced with a similar dilemma in leaving his department, Wadleigh ultimately accepted the new assignment because "you don't say no to Jay Stratton," he told a classmate and close friend. It's unlikely that either Stratton or Wadleigh anticipated the stresses that lay ahead.

Wadleigh's agenda as dean focused on two concerns. One was to facilitate what he saw as the growing interdependence of academic and extracurricular affairs; he was a champion of quality on-campus housing and athletic facilities. In the eight years of his tenure as dean, the housemaster/tutor system in the dormitories and fraternities was strengthened; McCormick, Eastgate, MacGregor, the Stratton Student Center, and the Du Pont Athletic Center were designed and/or placed in service; and the proportion of undergraduate and graduate students in MIT housing was significantly increased.

Wadleigh's other concern was to recognize and capitalize on student contributions to MIT academic and administrative activities. By the mid-1960s, increasingly strident protests had become a way of life at MIT and other campuses, as students reacted to the nation's military policy and what they saw as its campus manifestations. As early as 1964, Wadleigh was emphasizing in his annual report his search for "new means to extend our ability to discuss, to argue, and to arrive at joint decisions with many student groups," and his annual reports thereafter provide a unique chronology of the increasingly tumultuous years.

His purpose, he said in summarizing those reports in 1969, had been to provide "some feeling for the complexity of the issues of concern and of the rising sense of disaffection among our

PHOTO: MIT MUSEUM, CIRCA 1964

students with our society's goals and structures." Through it all, he wrote, his goal had been "a proper balancing of two potentially irreconcilable principles—the protection of the right of dissent with administrative policy on one hand and the responsibility of the university to provide ready access to all relevant informational resources."

With the confrontations still escalating, Dean Wadleigh surprised much of the campus when he announced his plan to retire as dean in 1969. In his weekly press conference, he told *The Tech* that he "had made the most significant part" of whatever contribution he could make as dean. But a tribute by Steven C. Carhart, '70, the paper's editor, was probably closer to the mark: "This job . . . with massive commitments to accessibility . . . is one of the most demanding at the Institute."

By the fall of 1969 Wadleigh was in a newly-created office of vice president with responsibility for special projects. In this role, Wadleigh is generally credited as architect of the HMO-like MIT Health Plan, first tested in 1970 and put in place a year later. In 1975, he took on additional responsibilities as dean of the Graduate School, extending his concerns for adequate housing, social facilities, and affirmative-action programs to the lives of graduate as well as undergraduate students.

Wadleigh retired in 1982 and shortly moved to Swansea, Mass., where his engineer's passion for building and improving were applied to restoring old houses and automobiles.

Chair of the Corporation Paul E. Gray, '54, who as a young faculty member had been recruited by Wadleigh in 1963 into part-time work in the dean's office , wrote that "Ken Wadleigh's limitless energy and dedication to MIT, his extraordinary contributions, and his no-nonsense, efficient style have won him a special place in the history of this institution."□ —*JOHN MATTILL*

ClassNotes

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Charlie Ruckstuhl plans to fold up his consulting corporation and give full time to his new career, writing. On his 170 Laptop Macintosh, he's writing three biographies; his pirate great-grandfather, his horse-artist stepfather, Charles Hayward (whose papers he found in a trunk), and his own autobiography. Charlie has a 29-foot Coachman RV suitable for housing wife Muriel, Fredy, their wire-haired dachshund, and all the cellular and ham radio equipment needed for the normal Ruckstuhl existence. Charlie has a 4,000 record 78-rpm collection including all but 38 of the records that Fats Waller ever made.

Lou Rosenblum sent an article, "New England by Bicycle," by **Jack Sheetz** and **Frank Hutchinson**. It tells of their June 1940 trip through New England and up to Montreal and Quebec. The bikes were second-hand, three-speed Raleighs, and all their clothes and gear were in backpacks lashed to the bicycle carriers.—**Ken Rosett**, secretary, 2222 Americus Boulevard, North, Apt. 12, Clearwater, FL 34623

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We were all saddened by the loss of highly respected classmate **Ken Wadleigh**, who succumbed in July to cancer. (See obituary on opposite page.) We offer our condolences to his wife, Jeane, and to the other members of his family.

I am indebted to **George Freedman** for a moving letter about **Al Emond**, who passed away last March. "You may remember him during our 50th last year. He was the one in the wheelchair and the ten gallon hat. He had about a half dozen chronic conditions and accurately forecast at the time that he would never make the 51st. So he focused all his energies of his last year on coming to Boston from California one last time and on attending this reunion. He kept saying to me with a big grin as those festivities went on, 'I made it, I made it.' He also said that this was one of the happiest times in his life because his two sons, Kim from Hawaii and Bruce from California, without being asked, had seen fit to come with him so that he could show off MIT and his sons to each other.

"Al worked for most of his career for the Sherwin Williams Co. in the field of paint chemistry, some of it in the lab but most of it in the field as West Coast sales manager. He was proud of a number of his innovative paint formulations as well as of his repeated best-in-the-country sales records for that firm.

"I had known Al since our Revere (Mass.) High School days and from our daily commuting journeys to the Institute in his Model A. Although he had lived all the intervening time on the West Coast (Portland and San Diego) while I remained in Boston, we always kept in touch, seeing each other in the flesh at least once a decade."

Speaking of our 50th Reunion, at the Alumni/ae Conference awards lunch in September, our class received a Presidential Citation for the excellent organization of our 1993 classic.

Jim Reswick (Course II) reports his retirement on July 29 as associate director for research services for the National Institute on Disability and Rehabilitation Research, a division of the U.S. Department of Education. At a retirement lunch Assistant Secretary Judith Heumann cited Jim's accomplishments: the pioneering application of engineering design to the problems of the physically disabled, 15 patents, over 100 publications, membership in 11 learned societies and academies, two years as acting secretary of NIDRR. She concluded by presenting to him the DoEd's Mary E. Switzer Award. He also received commendatory letters from two senators, President Clinton, and Oliver North. Jim and Trudy are now enjoying his "unending series of weekends and holidays" at their home on Dead Run Drive, McLean, Va.

Due to an extended European tour in September, I can't make the deadline for the January Class Notes. I'll be back with you for February.—**Bob Rorschach**, secretary, 2544 S. Norfolk, Tulsa, OK 74114

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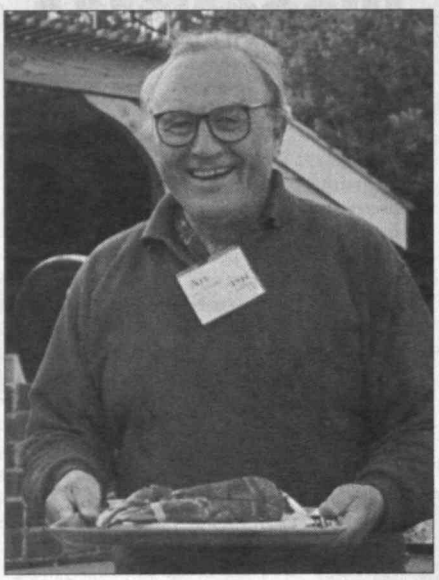
Edward Jefferson of Naugatuck, Conn., is in his 9th year of retirement and travels to the extent that the budget will allow. Otherwise, he stays busy maintaining home and garden, golfing, and attending to various church activities. There are four grandchildren all living in Colorado. . . . **Daniel Lord** is trying to get together with MIT and/or interested alumni/ae to set up an environmental center on his 120 plus acres with house and barn in New Hampshire about 30 miles from MIT. . . . **Robert Bartz**, president of the Corporation for Society, which was cofounded a dozen years ago by Bob and Norman Cousins, has for a great many years been involved in research, publication, advising, and consulting to many private corporations and governmental bodies as well as prominent individuals on matters pertaining to our well being as a nation in this exceedingly complex world. At present he is putting forth a plan called Visions III. This is a national goals program to adapt our society to the immense changes taking place due to rapid advances in technology. Bob would welcome involvement by many of you who could contribute vast knowledge in technology and management to the plan. Contact Robert Bartz at 781 West Seventh St., Claremont, CA 91711 for details of Visions III and plans for its implementation. . . . **William Wallace** returned to Schenectady, N.Y., when he retired from Bechtel Corp. after 40 years, the last 13 years in Indonesia as senior management advisor to the state-owned coal and tin companies, PTBA and PT Timah. At present, he is writing a book, *Healing the Wounded Giant*, proposed solutions to our country's problems. Bob Bartz and Bill seem to be on the same track.

James A. Leonard died while marching in the Cohasset Memorial Day parade last May 30. At MIT he was captain of the swim team, setting several pool records. He played lacrosse and was VP of the MIT Athletic Association. He left MIT to serve in the Army Signal Corps from 1943 to 1946 in the Pacific. He retired from the Army Reserves as a lieu-



Enjoying himself at the 50th Reunion festivities at the Samoset Inn in Maine, Alf Bjercke, '44, in turn delighted his classmates with stories from his life in Norway.

At the televised opening ceremonies for the winter Olympic games in Lillehammer, he had played the role of the high priest for the Viking wedding. His classmates may not have recognized him in his gold-trimmed red coat, wearing the helmet of an earl and blowing a birchbark horn. The celebration included Viking fare of moose and wild boar, washed down with 3,500 gallons of mead, the ancient brew from honey.

Bjercke was among those whose college career was interrupted by the war, serving in the Royal Norwegian Air Force. He recalled taking over a German anti-aircraft division in 1945, de-mobilizing it, and saving the weapons—for which he was inducted into the order of the Knights of St. Olaf.

Now he delights in the accomplishments of his four children—his eldest daughter is the only female sea captain in Norway—and 11 grandchildren. And having retired from his family paint and plastics company (now with factories worldwide), he has returned to school for an advanced degree in history.

tenant colonel. After graduating with a degree in chemical engineering in 1948, he worked in the Boston area as an industrial planner. During the past 30 years, Jim was active in community theater in 107 productions, acting and designing and building stage sets. He was a life member of the Curtain Call Theater in Braintree, receiving its J. Clark Settles Award for extraordinary service. He was founder of Darling Productions and active with the Quincy Dinner Theater. He leaves his wife, Frances "Fan" (Perry) and two sons, John M. of Hingham and Christopher P. of Washington, D.C.

We just received word of **Ed Eaton, Jr.**,'s passing. Ed, our class president for the 50th, was ill with cancer for some time but wanted to attend the 50th so that he could present the class gift at the Technology Day dinner. This he accomplished in grand style. He was a tireless worker for MIT over the years. He will be sorely missed by MIT and the class. We will have all the details on Ed in next month's notes. The class extends its sympathy to the families of Jim and Ed.—Co-secretaries: **Frank K. Chin**, 221 St. Paul St., Brookline, MA 02146; **Louis R. Demarkles**, 77 Circuit Ave., Hyannis, MA 02601

45 50th Reunion

It is early August, hotter than blazes, and we are wishing you not only a Happy Thanksgiving but a Merry Christmas as well!

Yes, it has been a windless, hot, humid summer that has found your Reunion Committee hard at work. Ann and **Bob Maglathlin** vacationed in Alaska; Carol and **Jim Pickel** had a transcontinental bus trip; Jan and **Charlie Patterson** have been hiking with grandchildren in Colorado; Jean and **Prexy Chris Boland** are always on the move; **Bill Meade** has moved to Braintree, Mass.; **Frank Gallagher** is constantly wind surfing; Louise and **Tom McNamara** enjoyed warm breezes in Whitefield, N.H.; while Fran and I entertain two young grandchildren for the month of August.

But do not fear, your 50th Reunion is under control; we do, however, need additional biographical data now if we are to meet our publishing deadlines. Earlier this week, **Waite Stephenson** called from San Francisco asking for a copy of the data he prepared 25 years ago. Of course, he had to add that he and Mary had just returned from seven weeks in Europe, four of which were spent in Paris. Wow!

In early July, Wesley Gustafson, '49, of East Weymouth and Peak's Island, Maine, wrote the following: "Greetings from the rocky coast of Maine! You are undoubtedly stunned to hear from me. I guess I should write once every 50 years. My graduating class was 1949, but whenever I get *Technology Review* I turn to the Class of 1945. I am tempted to write a long letter but will spare you probably boring details. My purpose in writing is to ask to be put on the mailing list, especially for the 50th Reunion. Since my retirement in 1989, my wife and I spend a lot of our summer time on this summer paradise in Casco Bay. To go to the reunion we will have to leave our island home temporarily, but it will be great to see old friends." Great to hear from you, Gus, and we hope that others who were associated with us early on might also join in our 50th.—**Clinton H. Springer**, secretary, P.O. Box 288, New Castle, NH 03854

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Unfortunately, I did not receive the deadline notice for the October issue of *Tech Review*, so there wasn't a column. This is just as well perhaps because all I had reserved were letters from our V-12 friends sent in May and June, which I will report here. Those of our V-12 group who gathered on the Class Day in June, included **Bob Hoffman, Ted Heuchling, Bill Rapoport, John Tayler,** and **Ned Tebbets. Charles Wellard** wrote saying he had gone to MIT. I was not familiar with Charles until I looked in our 1946 book. It shows that he spends winter in Florida and summers in Pinehurst, N.C. His old roommate and frat EAE brother is **E. Fulton Brylawski.**

Richard Steele wrote in May, a Course XIV graduate who lived and worked in Columbia, Maryland. Richard notified me that he has retired. In the last 16 years he has consulted as a senior VP of Birch & Davis Associates, of Silver Spring, Md., corporations specializing in health care management. Richard expects to remain a member of the board of directors. He is committed to his work on the National Health Council. "This has been an exceptionally rewarding experience, from which I also will retire." He and his wife, Martha, are involved in the Elderhostel program and expect to participate in several of its courses during the next few years. They look forward to seeing classmates at the 1996 reunion.

My next friend on my list is **Mario Vinci**, who stayed on in the Grad House through the V-12 program. He sent me a letter in June. Vinci says he is still active in the financial services industry, and has sold two million in securities and insurance. His travels in and around Irvine, Calif., keep Mario in and out of Las Vegas and other places. "We did take up ballroom dancing several years ago and can do a mean cha-cha, rumba, waltz, and tango." He'll be at the next reunion.

I had a grand two-week trip to Maine in mid-July to visit my sister who has a house right on Deer Island just above the Campobello Ferry. We toured all around.

We're counting up for "The Big One."—**Jim Ray**, secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Harold Juckett has retired from the Union Fork and Hoe Co., Columbus, Ohio. He now "escapes the northern winter cold" in his condo in Bonita Springs, Fla. . . . **David Lipitt** retired from General Electric in July after almost 47 years with the company. During that time he received numerous patents ranging from metals process control to industrial drive control technology. Dave and his wife, Kathie, have 5 children and 13 grandchildren; they live in Scotia, N.Y.

John C. Martin died in July on Mercer Island, Wash., where he and his wife Nancy had lived for 20 years. John had a long, distin-

PHOTO: BOB BLAKE

guished, and multi-faceted career. After leaving MIT, he held executive positions with 3M, Frigidaire Division of General Motors, and Addressograph-Multigraph. In 1974 he moved his family to the Seattle area and formed his own company, Martin & Associates. He consulted with a number of companies, including Boeing. In 1978 he joined Boeing full time and eventually became VP of Boeing Electronics and Chairman/CEO of two subsidiaries. In addition to his business career, John was always a strong supporter of higher education. At various times he was actively involved with no less than nine colleges/universities, including MIT. And he was active in other areas as well. He was a member of the Rotary Club of Mercer Island and the Rainier Club of Seattle. He was a member of the Classic Car Club of America and the BMW Vintage Car Club of America. He owned a 1938 BMW Type 328 roadster that he had restored to prize winning condition. John is survived by his wife and his son, John Jr.

John J. Ebersberger died in May at his home in Albertson, N.Y. He was still working with the New York State Public Service Commission. He was always very proud of his MIT education and had attended our 45th reunion in 1992. John is survived by eight children.—**R.E. "Bob" McBride**, secretary, 1511 E. Northcrest Dr., Highlands Ranch, CO 80126

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As part of their 50th Reunion in 1995, the Class of 1945 is sponsoring a Navy V-12 Reunion to commemorate the more than 1,000 individuals in the program from July 1943 to February 1946. The largest gathering is expected during cocktails and dinner on Friday, June 16, 1995.

Denny McNear, president of our class, has accepted another major office in support of MIT. He was recently appointed chairman of the Katharine Dexter McCormick '04 Society. The society was formed to recognize and thank those who have thoughtfully supported the Institute through MIT Life Income Fund gifts, estate gifts, and other charitable gift arrangements. . . . Jean and **Warren King** continue to divide their time between their original home in Winnetka, Ill., and another home in Palm Springs, Calif. Warren plays golf three days a week. They recently visited their children and grandchildren in Vermont, Boston, and Westerly, R.I. While in Boston, they met with the student who received the scholarship they funded at MIT. Warren commented that, not surprisingly, the student is typical of MIT students—quiet and hardworking! . . . Carolyn and **Dick Snow** have attended four Elderhostels with a fifth planned soon. They spent three weeks in the British Isles and plan a two-week trip to Switzerland and Italy. He usually plays golf three times a week.

Eugene Purdum retired and now wonders how he found time to earn a living before retirement. He recently enjoyed judging fourth grade science fair projects for a local school. . . . **Bill Riordan** missed Technology Day in order to be with his new granddaughter. He reports that his brother, **John Riordan**, died earlier this year. John joined the faculty of the University of Michigan's School of Engineering in 1968 and was professor emeritus at the time of his death. He was especially adept at dealing with students on a one-to-one basis. His fields of expertise were mathematics, statistics, and computers. John published in the area of programming methods and Fourier transforms.

Peter Guerico died recently. He had been a senior VP with Ametek, Inc., in Scarsdale, N.Y., since 1989. Before that, he was VP of the specialty metal division of Charles Pfizer, Inc., in Manhattan for 39 years. Peter and his wife, Jane, were living in Scarsdale. . . . **James Leonard** died while marching in a Memorial Day parade in Cohasset, Mass. Jim was class president during our junior year and captain of the Swim Team. More recently, he swam competitively in the Senior Olympics. He worked as an industrial engineer and was active in community theater on the South Shore. . . **Robert Charney** died recently. He had been living in New York City. On behalf of our class, I extend our sympathy to the wives and families of these classmates.—**Marty Billett**, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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Please send news for this column to: **Fletcher Eaton**
secretary, 42 Perry Dr.
Needham, MA 02191
(617) 449-1614

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45th Reunion

By now you should have received some detailed information on our 45th Reunion. Please give serious consideration to joining your classmates next June in Newport and on campus.

On a brief visit to New York City I was able to contact two classmates. **Herb Hochberg** continues with Ladenburg, Thalmann, a NYSE firm. . . . **Paul West** worked for Colgate-Palmolive until the Korean War called him away. When he returned, he entered law school and became a patent lawyer. In addition to U.S. clients, he deals with offices in London and Munich.

Suren Semonian retired after 35 years with Uniroyal and built a house in North Scituate, R.I. He has found he enjoys gardening—vegetables, flowers, on up to landscaping. He completed a Master Gardener program at the University of Rhode Island and now serves there as an advisor to gardeners. He maintains a veterans cemetery. One of these days he plans to wash up and do some serious recreational travel.

Gus Doering reports from Windham, Maine, that he is enjoying traveling and sailing now that he is retired. He looks forward to seeing you all at reunion.

There is some sad news this issue. **John Killheffer** died in January 1993. He had been living in Somerset, Mass. Some further news on **Harry Tecklenburg**, whose demise I reported last issue. Harry was general manager of Norwich Eaton Pharmaceutical, Inc. Prior to that he was senior VP of Procter & Gamble. At P&G he led development of disposable diapers.—**Robert A. Snedeker**, acting secretary, Seven Mashie Way, North Reading, MA 01864; **John T. McKenna**, secretary, P.O. Box 146, Cummaquid, MA 02637

ClassNotes

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We received word of the retirement of **George Butzow** as chair of MTS Systems Corp. of Minneapolis. I remember hearing from George of how his company saved the beautiful John Hancock building in Boston from the brink of condemnation. This glass and steel structure was plagued by a wind-induced swaying problem. He designed a unique damping system using spring-loaded 300-ton lead weights floating on pans of oil installed on the next to top floor. If you chance to meet George, have him fill you in on the many other details of this project, such as how the weights were brought into an upper floor of an already completed structure whose elevators could not handle the loading, and the reason why the damping system was not placed on the very top floor.

The Acoustical Society of America recently celebrated the centennial of one of America's most important pioneers in their field, Wallace Sabine. Among his many other accomplishments, Sabine designed the acoustics for Boston's magnificent Symphony Hall. He altered an earlier design that would have proved disastrous, and made it into what is perhaps the world's most acoustically outstanding concert hall. The general chair of this international symposium, held at MIT, was **Bill Cavanaugh**. The three years of planning that went into the conference were evident in its success, attracting attendees from all over the world. Assisting Bill was **Parker Hirtle**, who organized a tour of the Boston area's other Sabine acoustical accomplishments, such as the Boston Public Library, the Old South Meeting House, and the Parkman Grandstand on the Boston Common. During the conference, Bill, a fellow of the Acoustical Society, was elected to their executive council.

Sadly, we have heard of the passing of **Cooper Reid McCarthy** on April 30. He was a former publisher and editor who retired in 1991 as executive of the National Electrical Manufacturing Association. Among his accomplishments were contributions on boating in the *Encyclopedia Britannica* and on electronics in Grolier's *La Science Pour Tous Encyclopedia*. We extend our condolences to his wife, Elaine, and his four children.—**Martin N. Greenfield**, secretary, 25 Darrell Dr., Randolph, MA 02368

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Last month I reported the death of **Hawley K. Rising**, and mentioned that I had no information about him. His wife, Joan, has kindly provided a few details. Hawley, who died unexpectedly last March 7, had worked for the MIT Instrumentation Laboratory, Lincoln Laboratory, MITRE, and Bolt, Beranek and Newman. She notes that in addition to his work, his great loves were his family, music, hiking, astronomy, and an all-encompassing "nature." In addition to his wife, he is survived by four children, grandchildren, and a brother and sister.

Joan refers to an "MIT celebrates the humanities" event at a recent Alumni/ae weekend, and says, "I can remember when it was

all initiated—Hawley came home grumbling about having to read a novel. His horizons (were) broadened considerably; his passion for reading endured. But novels? Only a few—if, perhaps, airplanes or history were involved."

David Wallace, a principal of Wallace, Floyd, and Associates, Inc., a Boston architecture and planning firm, has been accepted to the American Institute of Architects' College of Fellows. Judging from the announcement, it seems that the Commonwealth does not consider undertaking a large public works or planning project without advice from Wallace, Floyd. In addition to a bachelor's and a master's degree in architecture from MIT, David is also a graduate of Middlebury College.—**Richard F. Lacey**, secretary, 2340 Cowper St., Palo Alto, CA 94301; e-mail: <lacey@hpl.hp.com>

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For a full year I have warned you what would happen if I ran out of news. Now you face the reality. To begin, I am reminded of a hilarious "stunt night" evening during 1951 at Camp Technology (the former MIT Surveying Camp for Course I and XVII students), a night that included, among other notable happenings, a joke told by **Frank Vitek**, as I recall. It went somewhat as follows: Upon returning from his summer vacation, and after being greeted at the railroad station by his butler, the master asked: "What's the news at home?" The butler replied: "There's no news at home . . . except for the dog." "What about the dog?" the master asked. The butler replied, "There's no news from home . . . except the dog died from the awful smell." And so on and so forth.

Likewise, I am forced to tell you that there is no news . . . except Jane and **Gil Gardner** joined Kay and me for dinner a week or so ago, and Jackie and **Bill Gouse** and I have exchanged phone calls during the last three or four weeks (concerning weighty matters such as gas versus electric air conditioners, reliable and competent carpenters, and first-rate kennels for pooches).

And, beyond doings with or about classmates, there is no news. . . . except for the Wohl family annual trek to and treat at the Inn at Little Washington; for those who yearn for the best in food, service, elegance, comfort, and civility (plus peace and quiet), there probably is no equal. And there is no news except for the fact that yours truly (plus one or two helpers at a time) has designed, planned, and built a second-floor sunroom addition to our master bedroom; all in all, a great success, except for the fact that I now weigh only 130 pounds. But the good news is that I can now easily photograph our "private bird sanctuary" with ease.

Again and again (as FDR would and often did say), please send me notes and information so that I do not have to fill this column so frivolously.—**Martin Wohl**, secretary, 4800 Randolph Dr., Annandale, VA 22003, (703) 354-1747

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It was five months ago, but the grand 40th Reunion is still deeply etched in the memories of those of us who were able to attend. From the reception at President Vest's home on Wednesday evening through the goodbyes as everyone began journeys home after returning from Nantucket the following Monday, the celebration was well planned and thoroughly enjoyable. **Bob Warshawer**, our reunion chair, deserves our hearty applause for outdoing even his great reunions of the past.

The dinner at Joe Tecce's Restaurant in Boston, following the reception at the president's home, gave everyone their first chance to renew old friendships in a relaxed atmosphere while enjoying an excellent meal and fine music. The next day, Thursday, June 2, featured a bus tour for those who wanted to see how the area had developed since their last visit, and the traditional festivities surrounding Tech Night at the Pops: an excellent buffet dinner, the Pops itself, and a post-Pops reception at the MIT Museum. The Pops concert was highlighted by the outstanding work of **Paul Gray**, who took the baton from John Williams to conduct a rousing "Stars and Stripes Forever." The reception at the museum gave our class the opportunity to be the first ones to see, close-up, the replica of the MIT security car that had been placed atop the Great Dome a few weeks earlier—an MIT "prank" that made national news. Friday was Technology Day, with an excellent program highlighting the arts at MIT. At noon, the annual Technology Day luncheon included reports from the various reunion classes on the success of their Class Gift efforts. We can be very proud of the $4.6 million-plus presented to President Vest by our Reunion Gift Chair **Ron Kurtz**, who clearly did an excellent job. The class photo was taken, with much ado, immediately following the luncheon.

The official dinner was held Friday evening at the Boston Harbor Hotel. Amid the high spirits exhibited by everyone as they relaxed and felt more comfortable with people they had not seen for some time, the class officers for the next five years were elected. I am not sure everybody noticed who they were voting for, after freely partaking of our official class spirits, Chateau La Teque, and a superb meal. The wine, of course, was supplied by **Mickey Sama** as usual. In any case, Mickey was elected class president (so maybe everyone did notice), and the other officers are **Bob Anslow**, **Lou Mahoney**, and **Joe Scheller**, vice-presidents; Bob Warshawer, treasurer, and **George Schwenk**, assistant treasurer, **Ed Eigel**, secretary; **Dean Jacoby**, reunion chair; **Phil Sayre** and Bob Warshawer, reunion vice-chairs; and **Joe Blake**, immediate past president. Joe, of course, merits our sincere thanks for his outstanding work in guiding the class resolutely toward the 40th Reunion. (Yes, Bob Warshawer is taking a sabbatical from running our reunions—at least for a while.)

On Saturday morning, some 80 stalwarts stumbled out (relatively) early to move on to Hyannis and board the ferry for Nantucket. With a minimum of confusion over baggage and land transportation (although Bob Warshawer was running around giving the impression that he was singlehandedly holding the world together), all arrived and settled in at the Nantucket Inn with plenty of time to get ready for the informal reception and dinner. There followed a day and a half of pure relaxation as everyone continued to catch up on what had happened to everyone else over the past 40 years. Then, on Monday afternoon, everyone had to return to the real world.

More than 200 classmates, spouses, and friends enjoyed a truly outstanding reunion, and all vowed to be back for number 45. And for those of you unable to join us this year, it's not too early to start thinking about 1999.

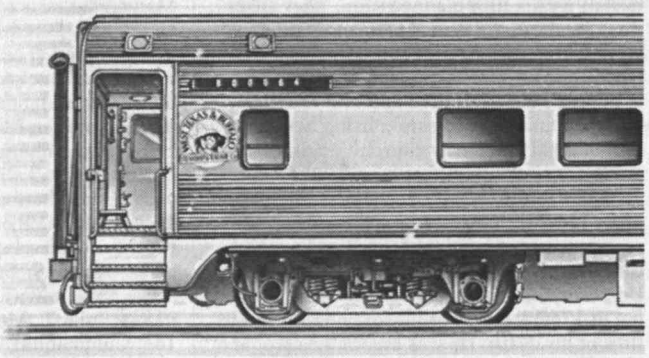
A lot of news about individual classmates was gathered at the reunion, and even more is arriving here in Connecticut every week. In our next issue, we'll begin the new reports. Meanwhile, drop me a line about yourself if I didn't get your news in person.—**Edwin G. Eigel, Jr.**, secretary, 33 Pepperbush Lane, Fairfield, CT 06430

55 40th Reunion

William Chandler reports that he finally finished a "gerontological" PhD in business administration/management at the University of Arkansas in May. His focus was on strategy/policy and MIS. After receiving an SB from Course XV, Bill went on to get an MBA in 1971. . . . **James Abrahamson** has been named a director of Western Digital Corp. of Irvine, Calif. He continues as chair of the board of Oracle Corp. in Redwood Shores.

Once again, **Ralph Wanger** was the subject of a feature article in a national magazine, this one in the June 6th issue of *Newsweek*. The article dubs Ralph the "Dean of Small Cap Investing." His Acorn Fund, and the more recently formed Acorn International, have performed exceedingly well, and Ralph has received much-deserved praise for his management of them. Sorry to have to say that at last report both funds were closed to new investors.

Allan Schell has completed a distinguished career of service to the Air Force and was honored at a retirement ceremony at Wright-Patterson Air Force Base in June. After receiving SB and SM degrees, Allan continued studies at the Technical University of Delft, Holland as a Fulbright scholar. He then returned to MIT, where he was awarded an ScD degree in 1961. In 1976 he became director of Electromagnetics of Rome Air Development Center, and in 1987 assumed the duties of chief scientist of the Air Force Systems Command at Andrews Air Force Base. When the Air Force Material Command was created in 1992, he moved to



Wright-Patterson as the deputy director of science and technology. Over the years, Allan has been a leader in the electrical engineering community, holding several offices in IEEE. We understand that his short-term retirement plans included a wedding for one of his daughters this past summer, and moving back to the D.C. area where we look forward to seeing him.

By the time you receive this, it will be time to start writing holiday greeting cards. As you catch your friends up on what has happened during the past year, send a copy to us for inclusion in the Class Notes of 1995.—Co-secretaries: **Roy M. Salzman**, 10643 Montrose Ave., Apt. 2A, Bethesda, MD 20814; **James H. Eacker**, 3619 Folly Quarter Rd., Ellicott City, MD 21042

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Victor C.A. Vaughen reports that he has formed his own consulting company, Vaughen Enterprises, to provide consulting services in chemical engineering and safety, consulting services in business and professional ethics, and mediation/arbitration services for a career change. Victor's new company is doing well.

I regret to report that **David McBride III** died on December 29, 1993. He had just accepted a new contract enabling him to return to the New England area in 1994 to work on a new project. He is survived by his wife, Jean.

Send news to Co-secretary **Ralph A. Kohl**, 54 Bound Brook Rd., Newton, MA 02161

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Please send news for this column to:
John Christian, secretary
23 Fredana Rd.
Waban, MA 02168

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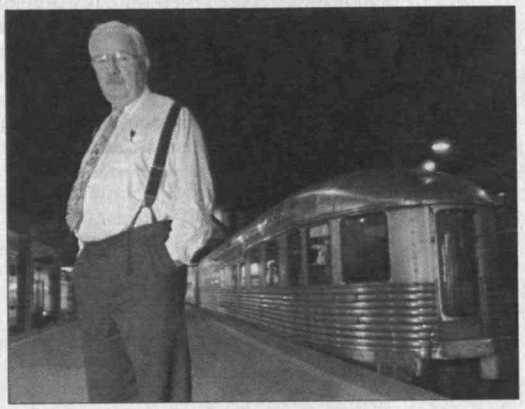
Al Russell reports: "While on our way home from a three-month sabbatical in Rome, Beth and I stopped off to visit Ursula and **Bob Baher** in Bad Homburg, Germany. We had a grand visit capped off with an evening slide show that even included archival photos from our days at MIT. Bob also arranged for us to join the MIT Club of Germany for a walking tour of Frankfurt with stops at architecturally significant landmarks and at various eateries of the city. The tour was organized and led by a very charming Ms. Margit Tappeiner who (now what are the odds of this) we encountered two days later while touring on our own. Also on the walking tour were: Martin Schloh, '90, Franz Drees, '89, Andreas Bommarius, '82, Ingfried Gouenig, '87, Daniel Kennedy, '69, Reynold Lewke, '76, and Ramiro Garron-Torrez, '77. All these MIT alums appear to be doing well, and the general consensus was that Germany is a pretty good place to be working and living. As for Beth and me, we are glad to be back home with our 3.5 grandchildren, the cat, and all our other hometown friends."

Evan Ziporyn, the holder of the Class of 1958 Career Development Professorship, sends us an update on his activities since our 35th Reunion: "It was wonderful to meet members of the Class of 1958 at the reunion in Maine last summer. My wife and I had a great time, and both the atmosphere and the scenery were of course spectacular. It has been a productive year for me because the support provided by the class has enabled me to complete several different types of projects in my work with the composition and performance of Balinese music. I've completed four large works for chamber ensembles, two solo works, and the first draft of a full-length opera. Currently, I'm working on a new piece for a brass orchestra in Holland, a solo cello work for a renowned Israeli virtuoso, Maya Beiser, and a new work for a Balinese gamelan (percussion ensemble).

"This level of productivity was possible due to the upgraded home studio equipment your class grant has allowed. As a performer, I've given solo concerts in England, Slovakia, Belgium, Holland, New York, and at MIT. Also, I have performed as a member of two ensembles, the Bang on a Can All-stars and the Michael Gordon Philharmonic, at concerts in New York and London. At MIT this past year, I started a new 25-piece percussion orchestra, using traditional instruments from Bali, that is composed of students and community members. While class funding kept the group afloat in the early months, it is now self sustaining from performance revenues. I'm extremely grateful to the Class for giving me these opportunities, many of which simply would not have happened without your support. I look forward to updating you again in the future."

At MIT, **John Deyst** has been named the Hunsaker Professor for 1994 in the Aeronautics and Astronautics Department. . . . That's all for this month. Hope everyone has a wonderful Thanksgiving and Christmas Holiday season. See you next year!—**Mike Brose**, secretary, 75 Swarthmore St., Hamden, CT 06517



Joe Goodell, '59, arrived at his 35th Reunion in grand and classic style—aboard his private passenger train car, the* Dagny Taggart.** ***Starting life in 1949 on the N.Y.–St. Louis run of the New York Central RR, the car underwent four name changes with as many railroads before being acquired by Goodell's West Texas & Buffalo Steamship & Railway Co. She is named after the heroine in Ayn Rand's novel* Atlas Shrugged, *and is available for hire.

ClassNotes

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After a wonderful reunion at MIT and in Maine, and a very hot summer, your newly elected secretary (one weakens at reunions!) is back in action. Kudos to our new Class Officers, **Jack Fisher** (president), **Art Colias** (treasurer), **Dave Packer** (secretary), **Dick Sampson**

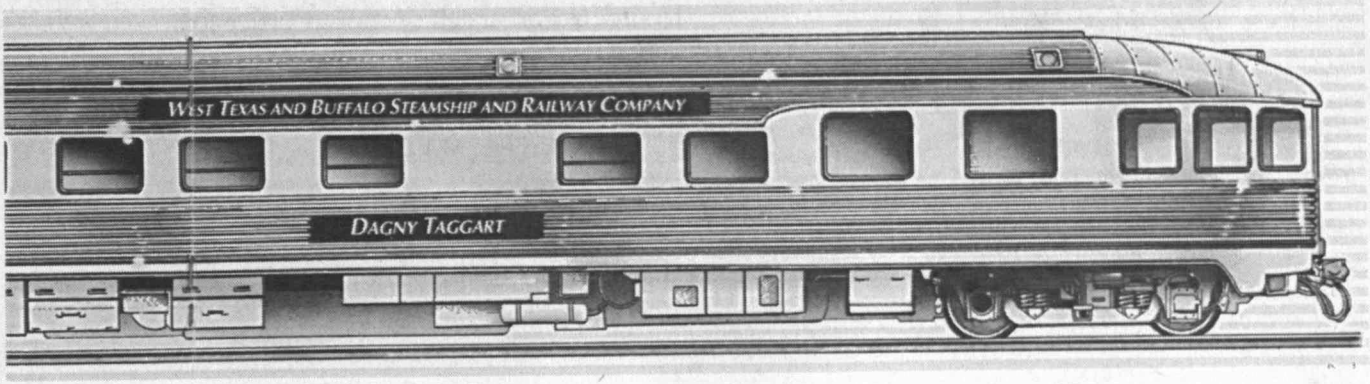

PHOTO: L. BARRY HETHERINGTON

(class agent), **Ed Vrablik** (40th Reunion chair), and a strong host of vice-presidents covering the planet, to be detailed later (when I find my notes).

Sadly, I received notice of the death of **T. Neil Divine** in Los Angeles. Neil passed away of AIDS-related complications on January 27, 1994. Neil followed a bachelor's in physics at MIT with a master's at Michigan and then went on to CalTech where he switched to astrophysics, doing his doctoral research on the evolution of helium stars, which now serves as part of current star formation theory. In 25 years at CalTech's Jet Propulsion Lab, he made many fundamental scientific contributions, helping to define the diverse and complex environments to which many JPL space probes would be exposed. His specific contributions in support of Voyager, Galileo, CRAF, and Cassini missions included defining the radiation belts around Jupiter, Saturn, Neptune, and Uranus, and the dust environment arount Halley's and other comets. During his tenure, he served as a mentor and inspiration to many younger space physicists who benefited from both his scientific incisiveness and quick wit. He enjoyed an outstanding international reputation, and was recently a guest of the Max Planck Institute in Heidelberg, where his just-released work on predicting meteoroid and space debris environments was greeted with great interest and may form the basis for all future models of these environments.

T. Neil Divine

Through his work, Neil made a significant contribution to the success of some of our greatest space missions and to mankind's peaceful exploration of space. For this kind and unassuming man, this represents a fitting legacy. Donations may be made in Neil's name to the AIDS Project Los Angeles.

J. Richard Swenson reports from Seattle that he has joined the MIT Club of Puget Sound to which Paul Gray gave a refreshing talk at the Space Needle, very candid and knowledgeable in nature.

Finally, **Michael D. Intriligator** appears in *Who's Who in America*, which notes he is professor of economics at the University of California/Los Angeles, where he is also Professor of political science and director of the Jacob Marschak Interdisciplinary Colloquium on Mathematics in the Behavioral Sciences. Mike received a PhD at MIT in 1963 and directly joined the UCLA Department of Economics. His publications span a wide range of economic issues and strategy and arms control.

That's all for now. Again, I urge you to **actually do it**—to send an update which will be much appreciated by your classmates. **—Dave Packer**, president, 31 The Great Road, Bedford, MA 01730, (617)-275-4056

60 35th Reunion

I don't have any additional information on our 35th Reunion, but rest assured your reunion committee is hard at work. Keep planning to get together with your classmates next June 15-18 for a great, long weekend!

Mark Pratt writes that after 30 years with Exxon he has taken early retirement and has accepted the position of VP and COO of Ceratherm Separation Inc. in Waltham, Mass. Ceratherm Separation is a joint venture among Exxon, Corning, and Ceratherm Corp. and was formed to commercialize patented ceramic membranes for liquid filtration and particulate removal from hot gas streams. Mark reports that he is excited by the opportunity of building a successful company. We are, too, Mark and best wishes. (Tell us how things are going at the 35th.)

I had a pleasant phone chat with **Ben Harris**, who has recently rejoined the singles scene. (Ben, too, lives in Arlington, Va., but unfortunately most of our getting together is via phone.) Ben has his own consulting firm, BTH Associates, and is engaged, inter alia, in work with the FAA and Loral Corp. On the leisure front, Ben says he is into long-distance walking—saves the knees—and is working to become a certified squash official. We talked about the differences between the U.S. and U.K. versions of the game, and how U.K. rules and court size are the world standard. Thus, for officiating in international competition, Ben has to make some adjustments in the

game he has been playing for many years. Ben reports that his son, Peter, is in the film business in Toronto, and that daughter Mandy is pursuing a singing career and continues to reside in California after graduation from the Claremont Colleges.—**Frank A. Tapparo**, secretary and class agent, 15 S. Montague St., Arlington, VA 22204

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E-mail comes through again! The other day **Henri Schnurmann** got on the Internet from his office in Hopewell Junction, N.Y., and sent this epistle: "I am now in my 31st year with IBM (not a small feat these days), and feel like a dinosaur of a bygone age. Having reached several years ago the level of senior technical staff member, and with no place upwards to go, I got interested in patent law, having written myself a number of patent applications for my own inventions. I took and passed the Patent Bar Examination and was thus admitted to practice before the U.S. Office of Patents and Trademarks. Since then, I am spending a great deal of time writing and prosecuting patent applications, and lately heading patent enforcement activities, which makes me feel more like a detective than an engineer turned patent agent! My married daughter has made me a four-times grandfather, my youngest daughter is a teacher at one of the local schools, and finally my son has left us for an out-of-town school. My wife and I are trying to adjust to an ever increasing empty house, not an easy feat. I spend a great deal of time on civic activities, not the least with an 'interest free' loan society that lends money to those that are considered high risk by financial institutions." Thanks, Dan.

More conventional means were used by **Sandy Wagner** who wrote by snail mail. That's because he was laid off by IBM's EduQuest Division out in Silicon Valley. He reports that he got another job in the area, this time with Curriculum Corp. in Sunnyvale where he is director of mathematics software development. Congratulations! . . . **Malvin Teich** wrote that he just became a Fellow of the Acoustical Society of America for "contributions to the understanding of the auditory neural spike train." This is just one of a string of fellowships in learned societies. It's quite a collection! He is a Fellow of the American Physical Society, Optical Society of America, AAAS, and IEEE. Wow!!! He is at Columbia in the Departments of Electrical Engineering and Applied Physics, where he has been on the faculty since 1967.

Keep the mail (snail or e-) coming. It's good to hear from you.—**Andrew Braun**, secretary, 464 Heath St., Chestnut Hill, MA 02167, or via Internet: <andrewb820@aol.com> or <abraun@husc4.harvard.edu>

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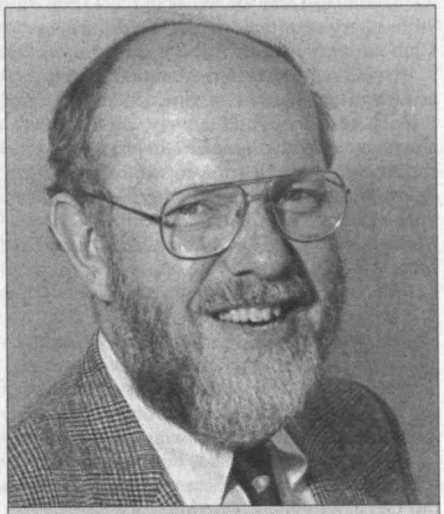
Received a short message from **Roger Sullivan** by e-mail in response to my inquiry about ERIM in the last Class Notes column. Roger left ERIM to accept an exciting new opportunity at IDA before **Jack Walker** became acting president at ERIM. Thanks, Roger, we are glad to learn that you are now "on-line" with MIT1962 and hope to hear more about your experiences in the Washington, D.C., area. If I'm not mistaken, Roger, Jack, **Ed Feustel**, and yours truly were all in the same freshman section in 1958–59. It's a real pleasure to keep in touch with the old "gang" after all these years.

Alan Kotok is also on MIT1962, and his "best" e-mail address is <kotok@memit.enet.dec.com>. While casually looking through a book at the MIT Museum on computer hackers, I noticed that Alan is given credit as being one of the notable early hackers while an undergraduate at MIT. Perhaps Alan can tell us how he became so famous, and how that experience has contributed to his professional success.

The following message came in on the Internet just after I had completed the last column, so I'm passing it along before it gets lost on the information superhighway. After five years in the writing, **Tom Sheahen** has completed



HAVE YOU WRITTEN TO THIS MAN LATELY?

Hank McCarl, '62
Class Secretary

his magnum opus, entitled *Introduction to High Temperature Superconductors,* to be published by Plenum Press in October, 1994. Tom hopes all his classmates will buy the book out of general loyalty, or better yet, because they actually want to know something about this field of technology. The book is tutorial in style, aimed at engineers and managers, rather than limited to MIT physicists. Tom's major hope is that it will be used in college courses about high temperature superconductivity. On a more personal note, Tom continues to be very active in refereeing amateur ice hockey, a skill he developed by playing intramurals on the MIT outdoor rink behind the old Briggs field house. After 35 years as a referee, there is general agreement (among mathematicians and players alike) that Tom's talents as a referee are billions of times greater than they were as a player in 1959–1962. After reading recently about the trials and tribulations of officials in little league sports, I hope for Tom's sake that the ice hockey fans don't get quite as riled at the officials as they seem to become in baseball, football, soccer, and other amateur sports.

ClassNotes

Peter Maas sends his greetings from Scotland with the news that the MIT hack of the campus patrol car got publicity world wide! There was a lovely picture and caption in the *Guardian* newspaper "over here in Great Britain." The picture now hangs with pride of pinboard place outside Peter's office at Strathclyde University (Glasgow, Scotland) in the Physics & Applied Physics Department where he has taught, done research, administered almost anything, etc., since 1970. Peter says that it is a typical academic life ... do it all yourself. FYI, the actual mock-up of the campus patrol car used in the hack will be on display in the MIT Museum, where it has found a happy home along with one of the plastic cows from the Hilltop Steak House on U.S. Route 1 in Saugus.

Phil Schmidt comments that one of the wonders of cyberspace has finally occurred—"After all these years of being too lazy to send in any class news, your (class secretary's) persistent presence in my (e-mail) mailbox has finally got the best of me!" Phil is entering his 25th year as a faculty member in mechanical engineering at the University of Texas in Austin. He really enjoys the academic life and wouldn't think of leaving it. He is teaching in the thermal systems program and doing research in microwave heating for industrial applications—these activities have kept him beneficially occupied for lo these many years. Weekends are spent enjoying music and the scenic beauty of the Texas hill country. Phil and his wife, Donna, have just passed a milestone in their lives: graduated their first kid from college, and have two more in the pipeline. Now with all the kids out of the house, Donna has decided to go back to college to get a master's degree. Phil is considering the possibility of going back to graduate school in medicine so that the entire family can sign over all of their worldly possessions to the student loan fund. They calculate about 10 more years of tuition payments.

Phil spent a weekend visiting **Pete Neal** and his wife, Merrie, in Buffalo, N.Y. Pete's been with Moog Corp. (in hi-tech electro-hydraulic control systems) as a senior tech staff member and manager for about 20 years, after stints with Bell helicopter in Texas and Calspan in Buffalo. Pete and Merrie have a beautiful home on the shores of Lake Erie, two boys and a girl (more accurately, two men and a woman), and a golden retriever. This past May they finished the college routine in grand style by graduating not one but two of their brood. The third graduated several years ago and is gainfully employed. Pete seems to be experiencing a slight case of fiscal disorientation (read positive bank balance), but the family seems to be coping with this situation nicely. Both Phil and Pete send their best regards to the '62 crowd and look forward to hearing about our continuing adventures as we successfully navigate around the road kill along the information superhighway. The latest mailing from the MIT Museum Shop includes an ad for the "Smoot T-Shirt" with the explanation: "Smoots (for the uninitiated) are the painted markers on the bridge that crosses the

Charles River at MIT. The Smoot legend goes back to 1958 when Oliver Smoot, '62, the Lambda Chi Alpha fraternity pledge, was plunked down from one end of the bridge to the other, thus establishing its length at 364.4 Smoots plus one ear long. For the last thirty(-five) years his fraternity has maintained the tradition by repainting the original Smoots. The 100% cotton T-shirt is wrapped, front and back, with Smoots. M, L, XL Item #1070 $14.95" plus tax for MA residents.

John Banzaf, our famous anti-tobacco crusader and law professor, has been back in the spotlight vocalizing and orchestrating criticism of tobacco company executives on a network news show after the nationally televised Congressional hearings on nicotine in cigarettes.

Bill Koch has moved out of the acting-president's job at Kendall Square Research with the appointment of a new president, and has remained on the sports pages with his yachting victories over Dennis Conner in the 150th anniversary regatta of the New York Yacht Club out of Newport, R.I.

If you have access to the Internet, please send your personal news to: <MIT1962@mitvma.mit.edu>. Alternatively, you can send a message directly to me at: <uabhnm01@asncube.asc.edu>. If you can still communicate by traditional written methods, please send your news and personal notes to: **Hank McCarl**, secretary, P. O. Box 352, Birmingham, AL 35201-0352

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One nice thing that's starting to happen is that I'm getting a few contributions to this column from classmates who are not only talking about their own news, but are relating it to alumnews they read here about others in our class. Why not make this space interactive! For example, I received a letter from **Bohkee Yap**, Course VI, who was very interested in the experiences in Asia of **Shingo Nishikawa**, Course VI-A, and **Mike Maul**, Course VI, described here last issue (remember, you saw it here first)! He asked for their addresses. (I'll send them to you). Bohkee and his wife of 30 years, Rose, toured China for two weeks. Sounded like a great trip with them outrunning their young guide up the Great Wall. They were impressed by China's beauty, but also constantly worried about the minimal safety of the air flights. A Russian-made plane had crashed the previous week. It reminds me of the time when I was there and they miscounted the number of passengers. They were convinced we had smuggled an extra person on board and made us board and deplane several times before they were convinced there was no hijacker. A plane had been hijacked the week before. In Singapore, Bohkee met a classmate from grade school. He is now the prime minister, but they did not discuss the caning affair.

Roy Komack, Course VI-A, sent e-mail to say he has left Bytex Corp. and has started a sole proprietor (employee) company called Komack Management Services, Inc. His quote: "The best time to start investing is 20 years ago. The second best time is today." Did Samuelson know about this? You can reach Roy at <komack@aol.com>. . . . **Stephen P. Kaufman**, Course XIV-A, has become chairman of Arrow Electronics, Inc., in Melville, N.Y. He continues as CEO. . . . **Mark Ordower**, Course XVIII, wrote Tech to say that he is now building townhouses in inner-city Chicago for upscale buyers of all races, origins, lifestyles, etc. He finds it very exciting. He just celebrated his granddaughter's first birthday.

Speaking of creating excitement, you may be aware of how dynamic the artistic atmosphere at Tech has become in terms of visual, literary, and performing arts. This is due to a great extent to the Council for the Arts at MIT, which was founded by President Jerome Weisner in 1972. Not only has the Council supported performances at MIT and additions to the Institute's collections, but it has involved students in artistic endeavors and has, through the awarding of over $800,000 in grants, helped bring into being more than 700 arts projects and programs produced by, and including, a broad section of the MIT community. Members of the Council are appointed by the president to a three-year term. This year **Robert M. Levin**, Course XIV-A, and his wife, Bonita, were honored by being appointed to the Council. Congratulations.

Keep the alumnews coming! Try to get it to Tech or me by the first of the month. You can reach me by snail mail: **Shoel M. Cohen**, secretary, Dept. of Psychology, Nassau Community College, Garden City, NY 11530 or e-mail: Internet <71271.2627@compuserve.com> or Compuserve <71271,2627>. You can also call me at home at (516) 489-6465. It would be great to talk to you personally.

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Most of our news this month comes from classmates in Silicon Valley. . . . **Donald Levy** reports that after many years of talking about it, he has moved from New York to Silicon Valley. He is enjoying his new home and a position as director of development systems at Stanford. . . . **Jay Tannenbaum** is also located in Silicon Valley and is a consulting professor of computer science at Stanford. He is CEO of Enterprise Integration Technology (EIT), an R&D and consulting organization providing software and services that help companies do business on the Internet. EIT is the project manager of Commerce Net, a consortium of leading Silicon Valley companies that is fielding the first large-scale market trial of electronic commerce on the Internet.

The *Wall Street Journal* announced that **Lawrence Hootnick** has been named a director of NetManage, Inc., in Cupertino, Calif. Lawrence is president and CEO of Maxtor Corp. in San Jose. . . . **Ed Wolcott** reports that his son, Kedron, is now working for Tribe Computer Works, a small San Francisco company founded by an MIT graduate. His daughter, Chanky, is a fifth-grade teacher in Greenville, S.C. . . . **John Reed** has recently published two books that I believe you will find amusing: *Whistling Dixie: Dispatches from the South* and *My Tears Spoiled My Aim*. Both are Harcourt Brace paperbacks. John received a PhD from Columbia and is currently professor of sociology at the University of North Carolina. He is also the director of the Center for the Study of the American South. A daughter graduating from college prevented him from attending our 30th. . . . **Mark Ordower**, Course XVIII, wrote Tech to

say that he is now building townhouses in inner-city Chicago for upscale buyers of all races, origins, lifestyles, etc. He finds it very exciting. He just celebrated his granddaughter's first birthday.

Congratulations to **Leon Kratz** and **Andrew Silver** and the rest of the Reunion Gift Committee for their work. The 30th Reunion Gift was $1,226,749. . . . Leon is now an attorney in Hartford, Conn. At one of our reunion dinners he described some of his mountain-climbing adventures in South America and Russia. I found his talk so interesting that I took my son to see it when he presented it at an REI gathering the next month.

My son, Scott, will enter MIT in the fall. Having already rowed for four years, he is looking forward to crew. My daughter, Laurel, will be a senior at Franklin and Marshall College. . . . Please write or call—**Bill Ribich**, secretary, 18 Revere St., Lexington, MA 02173, (617) 862-3617

65 30th Reunion

Headline news for this column is **Cliff Weinstein**, who wrote and then followed up with a delightful interchange. Cliff has three children, Dena and Jonathon who attend Harvard, and Kenneth, who is still in high school. Jonathon was one of the team of six students on the winning U.S. team in the International Math Olympiad in Hong Kong in July. All six team members had perfect scores on the test (a first). Cliff was obviously quite proud of the event, as we all are.

Cliff continues to be at Lincoln Lab in Speech Systems, and was elected a Fellow of the IEEE "for technical leadership in speech recognition, packet speech, and integrated voice/data networks." He lives in Lexington with his wife, Georgia, who is a chemistry prof at BU.

Shingo Nishikawa writes that he is now in Hong Kong, still working for AT&T as VP for Business Development in a business unit. He enthuses over his location—Hong Kong is in the midst of the historic surge of Asia and his office has a panaromic view of the harbor—plus great food. I wonder if he recognized Jonathon Weinstein's heritage?

Steve Dreier has combined 20 years of experience in retailing and real estate development and is now CFO for Bright Horizons, a chain of child-care centers. Steve has two grown daughters, both living in Boston.

John Holdren writes that he has been chair of the Committee of International Security and Arms Control for the National Academy of Sciences since June 1993, and is splitting his time between Woods Hole (summers) and Berkeley.

On the **McKinney** home front, Jamison Gluyas (21", 8lbs. 7oz.) became our first grandson on July 27 after a marathon two-day labor by daughter Susan. We're obviously proud and pleased with our first male descendant. By the way, this points up the time delay in our columns due to editing/printing delays—I'm writing this column on July 27!

Write when you can.—**George McKinney**, secretary, 33 Old Orchard Rd., Chestnut Hill, MA 02167, (617) 232-4710, <gels@world.std.com.>

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Roy Schwitters writes that he is joining the University of Texas at Austin as S.W. Richardson Regents Professor of Physics following termination of the superconducting supercollider project. . . . An article in the *Buffalo News* cited **Stuart Shapiro**'s ongoing computer project to "build an English-language generally intelligent computing system." The system, called CASSIE, "speaks" English (for now through her computer screen) and carries on conversations in which she can tell you what she's thinking about and what she plans to do. Stu would like to have the system done by 2001. . . . **John Bobbitt** sent along a long catch-up e-mail message from Houston. He has spent 17 years in the oil industry. After accepting a nice package from British Petroleum, he started with a new company, Petrochemical Open Software Corp., a consortium of about 70 companies and governments, foreign and domestic, whose purpose is to set standards for E&P data. The governments of several countries have adopted the standards, providing a strong incentive to keep the standards and further build on them. John's wife, Peggy, works with a spouse relocation company that eases moves for the whole family and helps relocated spouses find new jobs. They have three children, aged 15, 20, and 23. As part of his mid-life crisis, John recently took up scuba diving and suggests you look for him and his son in Cozumel or the Caymans. Note that he is in no way related to his infamous namesake. . . . My mid-life backpacking adventures continue, this time marked by violent thunderstorms and a possible tornado which felled trees across the Appalachian Trail in western Massachusetts. We crawled under some and navigated around the larger areas of destruction. Great trip anyway.

Since so many more of you have e-mail addresses now, I want to remind you of the electronic mailing list for our class. You may join by sending a message to <listserv@mitvma.mit.edu> on the Internet or to <listserv@mitvma> on the Bitnet system. Your message should contain the line: SUB MIT 1966. You may then send messages to other classmates on the list at <mit1966@mitvma.mit.edu>.

On a somber note, I am sorry to report that **John W. Harris** of Bowie, Md., died in April. I have no other details.—**Eleanore Klepser**, secretary, 84 Northledge Dr., Snyder NY 14226-4056, e- mail: <vismit66@ubvms.cc.buffalo.edu>

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We sure can use some more e-mail. Please write to me at <jswanson@lat.com>. Any guess as to the percentage of our class that's on the Internet? All of the news this month (two out of two) is via this great communications vehicle. From **Alan Hausrath** we have the following: "My life is not much changed from the last time I wrote (a long time ago, I bet). I still teach mathematics at Boise State University and am currently associate chair. I am, however, old enough now to start reporting on the doings of my children! My daughter Libby, who just finished 11th grade at Boise High, will be spending the next two years at the United World College of the Atlantic in Wales. She was one of two Ameri-

cans selected to attend this international school which stresses leadership, international cooperation, and academics. Throughout her life, she will be able to say truthfully that she doesn't have a high school diploma although she will receive an 'international baccalaureate.'"

Greg Wight's *Fundamentals of Air Sampling* is finally available, and definitely destined for the *New York Times* best seller list. Greg and his family returned to Vermont in July after a fantastic year at the Air Force Academy in Colorado Springs, where he developed a new undergraduate air pollution course sequence and served as a distinguished visiting professor.—**Sharlotte** and **Jim Swanson**, co-secretaries, 878 Hoffman Terrace, Los Altos, CA 94024, email: <jswanson@lat.com>

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Greetings from the information superhighway! This is the first column based mainly on information received electronically. As Samuel Morse said, "What hath God wrought?" Please join the information age by sending your news to the address at the end of the column.

Don Baker has finished a PhD in soil physics at Colorado State, improving modeling algorithms. One contribution will allow many groundwater flow models to run several times faster on the computer. The other, an extension of vadose zone Darcian interblock conductivity means, will eventually improve landfill caps and liners, and nuclear waste containment. Paper abstracts are available on Internet at <dobak@csn.org>. . . . Julia (7), Max (5), Robyn and **Bob Metcalfe** have just moved to a sheep farm in Lincolnville, Maine, from California (after 22 years). His e-mail continues to be <Bob_Metcalfe@InfoWorld.com>. Bob is also moving ahead in the 'Tute's bureaucracy. He is on *Technology Review*'s board and has just been elected to the Executive Committee of MIT's Corporation, which means a Top Secret security clearance and monthly two-day meetings in Cambridge. He adds, "Good thing I've also just bought a townhouse on the river side of Beacon Street in Boston, overlooking (literally) the Great Dome across the river. The redo of the house is major (November), requiring, yes, an architect from the MIT faculty and a contractor who is an MIT graduate.". . . **Irwin Simon** has been elected a director of NBT Bancorp, Norwich, N.Y. He continues his main position as general manager of Procter and Gamble Pharmaceuticals-North America in Norwich.

That's all we have for now. Send your cards, letters, and e-mail to: **Gail** (ghm@nrc.gov) and **Mike** (mmarcus@fcc.gov) **Marcus**, secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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A little 25th Reunion feedback. . . . **Thomas A. Schonhoff** writes that he enjoyed attending the Pops concert in particular. "Although I saw quite a few old faces, I didn't see many 'familiar' old faces," he adds.

Roger Chang has been promoted to colonel in the Army Reserves. He has been working on upgrading information connectivity to the reserves and sharing training among the reserve services of the Navy and Air Force. Roger writes: "My son Mike is on the state all academic wrestling team. He had a 30-5 season. I help coach the team and might make a comeback after 25 years. We have a master's division for us more mature wrestlers!"

An electronic missive tells us that **Bruce Glabe** has joined Individual, Inc. as VP and CEO. Glabe was previously senior VP for finance and administration at Bolt Beranek and Newman in Cambridge. Individual, Inc. provides electronic information services.

Mark B. Lively wins the letter-of-the-month contest. He writes from Gaithersburg, Md.: "I seem to be one of the first members of the Class of '69 to be able to report a child attending the 'Tute. Peter is a member of the Class of '97, hoping to double major in XVI and XVIII. He decided to attend MIT when he was in the second grade, but delayed telling us of his plans until the ninth grade, when he said he was going to get a Brass Rat like mine. When he got to Cambridge, he joined Theta Xi, the same fraternity I was in, and started rowing, which was my major freshman activity. I haven't heard anything about an interest in the Concert Band, which I was in for my three upper-class years, and he is staying away from VI and XV.

"Peter invited me to the annual Theta Xi banquet in April, where I saw **Paul Bannister**, **Mark Wuonola**, George Blaszczynski, '71, and Jim Scott, '72. Mark is director-chemical sciences for the Du Pont Merk Pharmaceutical Co. in Wilmington, Del. Jim is a physician at the Harvard Medical School.

"The MIT Concert Band was having its Alumni/Anniversary concert the same night as the banquet. I tried to practice with the band that morning, but eventually realized that I had an E-flat tuba and only knew the fingerings for a double B-flat tuba. So I gave up rather than ruin the concert by playing the wrong notes, though some would claim that didn't stop me 25 years ago. **Bill Grossman** was there to play drums. Bill is in the computer music business in New York City. Fred Schmidt, '61, was there to play the flute and take pictures. Six weeks later Fred gave me two snapshots when we both attended the annual meeting of the MIT Club of Washington, of which I have been treasurer for the last six years.

"Coincidentally, a few days later, I was talking on the phone with Bruce Smith, '71. We both work on pricing issues related to electricity and natural gas, though we have only talked by phone. I told him of my trip to Boston and we soon realized we had been in the band together, including the disastrous 1969 winter tour. Our bus was stuck on the Tappan Zee Bridge when it was closed and took 30 hours to go from Washington to Boston due to a blizzard. The other bus took 80 hours. Bruce is with Pacific Gas & Electric in San Francisco.

" . . . in June I ran into **Peter Peckarsky** who does technology and intellectual property law for Watson, Cole, Grindle & Watson, here in Washington.

"I missed the 25th Class Reunion, but I had my own reunion of sorts in April, both with my fraternity, and with my Concert Band. And I have similar smaller reunions throughout the year, such as the MIT Club of Washington functions, when I talk with other MIT alumni, whether they are in my class or are decades away from me."

O.K. you energy guys and financiers, don't

tell me I didn't warn you: The first (partially) water-fueled cars and buses are already on the road! Grab a copy of *Business Week* (August 8, 1994, page 47) to find out about the patented Gunnerman process, which uses a 55 percent water-hydrocarbon fuel mix and manages to squeeze 30 percent more mileage out of a gallon of diesel fuel—as long as a nickel catalyst is welded inside the combustion chambers. Caterpillar Corp. has set up a joint venture with Gunnerman to produce engines and distribute the "A-55" fuel. Sounds a bit like the mysterious light-water cold fusion to me! Those of you who are fully electronic can reach me or submit class notes at Compuserve <76570,2270>. Via the Internet, use this form: <76570.2270@compuserve.com>.—**Eugene F. Mallove**, secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

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Sheldon Friedman is co-editor of *Restoring The Promise of American Labor Law* published by ILR Press of Cornell University. . . . **Peter Lee** is director of Operations Improvement for The Permanente Medical Group, Inc. . . . Karen spent a busy summer as acting business/financial editor at the *New York Times*.

Remember to return your questionnaire for inclusion in our class reunion book.—**Greg** and **Karen Arenson**, secretaries, 125 W. 76th St., Apt. 2A, New York, NY 10023

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James L. De Lucas, MD, is still at Plattsburgh Air Force Base in New York as chief of family practice. This base is due to close in September 1995. James will retire from the Air Force and stay in private practice in the Plattsburgh area.

Your class officers are getting together to plan our class gift. Save your money for a gift to MIT and some tickets to attend our 25th Reunion. I was recently named a Fellow of the State Bar of Texas Foundation.—**R. Hal Moorman**, P.O. Box 1808, Brenham, TX 77834-1808

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Shirley Wilson is an associate professor of math at North Central College in Naperville, Ill., and recently received the Dissinger Memorial Award for distinguished teaching and service. She was described by her nominators as "a teacher who expects the most from her students," and "the backbone of the math department." She has been active in curriculum reform and has served as faculty speaker and chair of the math department. This fall she will become associate academic dean. . . . **Richard Levin** is now vice-president, CFO, and general counsel for the Whitaker Corp. in Los Angeles.—**Dick Fletcher**, co-secretary, 135 West St., Braintree, MA 02184

ClassNotes

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Frederic "Ric" Mishkin was a compatriot for a while on the esteemed MIT golf team of the first year or two of our college existence. At long last we hear word of him: he has moved from being a professor of economics at the Columbia Graduate School of Business to becoming executive VP and director of research for the Federal Reserve Bank of New York.

Remaining in academia is **Martin Rosenberg**, now associate professor of art history and department chair at the University of Nebraska/Omaha. His book, *Raphael and France; the Artist as Paradigm and Symbol*, is being published by the Penn State Press. . . . **Mike Ashmore** has left Temple, Barker and Sloane to become managing director of Tradewinds in Cambridge. Sorry, but no word for us in God's country as to what Tradewinds does.

The rest of us are wishing to hear from the rest of you all—but please note the change in address (no, we haven't moved; Fauquier County has overhauled all its street numbers for a new 911-response system). Write or e-mail!—**Robert M.O. Sutton, Sr.**, secretary, "Chapel Hill," 7721 Churchill Ct., Marshall, VA 22115; e-mail: <sutton_bob@prc.com>

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Thanks to **Lionel Goulet** for 15 years of service as our class secretary, part of that as co-secretary with **Dave Withee**. At our 20th Reunion I campaigned vigorously and won this position in a "hotly-contested" election. We had a mini-reunion of MacGregor people. **Jim Olson**, **Willy Burke**, Debbie Orbach and **Tom Campbell**, Linda Nelson, and your new secretary toured the dorm after the Friday night party. MacGregor house opened during RO week in our freshman year, so we were the first to make our mark on the place. We were pleasantly surprised to see that our marks remained after 20 years. Another MacGregor alumnus, **Marty Davidoff**, was at the reunion, but he missed the tour. . . . **William Sayers** is engineering manager at Kimberly Clark Corp. in Conway, Ark. He is married to Shirley, and they have two children, Lizzie (13) and Billy (9). . . . **Brenda Kurnik**, MD, is head of the Nephrology Division at the Robert Wood Johnson Medical School in Camden, N.J.

Professor **Vivian Hartkopf** is the new head for the Architecture Department at Carnegie Mellon University. . . . **Bob Wake** does not lament the fact that he does not have a leather chair at the bank, nor has he ever commanded his very own tank. On the other hand, he has pursued activities that were beyond his imagination 20 years ago. He has done some time as a prosecutor, and he serves on the State Democratic Committee. He and his wife, Marcia, just finished celebrating their son's bar mitzvah in the house they are building in the Maine woods. . . . Speaking of the Maine woods, a reliable source informed me that **Jens Eldrup-Jorgensen** lives in the Maine woods. Perhaps he should write and tell us what he has been doing since we last saw him 20 years ago. . . . Some of you might find it easier to type a short note while at work instead of handwriting your news at home with all its distractions. If you have easy access to the Internet, please send your news to my e-mail address below.—Co-secretaries: Barry Nelson, 65 Hillside Ave., West Newton, MA 02165-2593, e-mail: <bnelson@cspi.com>; **David Withee**, Box 472, Two Rivers, WI 54241

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Please send news for this column to: **Jennifer Gordon**, secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036 or 18 Montgomery Place, Brooklyn, NY 11215

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We have a nice assortment of news from both the post and e-mail. For those of you with e-mail addresses who have not sent them in to me, please do so as soon as possible. We are starting to use our e-mail server and addresses to discuss ideas such as a new yearbook, perhaps on CD-ROM instead of traditional paper.

From the mails: **Marvin Bugg** has "moved to Noblesville, Ind. I'm covering the northern half of Indiana as a product development specialist (still with Monsanto). Trish, Bryan (11), and Emily (7) are all doing fine." . . . **Andrew S. Farber**, MD, is an "ophthalmologist practicing in Terre Haute, Ind. Sons: Daniel, 6, and Adam, 4.". . . **Andrew Chestnut** has "after passing a financial career with General Electric for 15 years, I joined Elf Sanofi (a French diversified pharmaceutical company) in 1991, in New York City. Recently, I was promoted to VP for finance of Sanofit Beaute, Inc., our largest affiliate in the United States. I live with my wife of 12 years, Heather, and our two children in Pelham, N.Y."

Via e-mail: **Larry Appleman** writes: "You may recall that I went to New England School of Law after finally finishing my MIT degree in 1987. I graduated summa cum laude from law school in 1991, and now I'm licensed to practice law in Massachusetts, Illinois, and the District of Columbia. I work in Cambridge at the Jurisoft division of Mead Data Central as a 'senior attorney software engineer.' At the same time, I'm still in school, studying toward a master's degree in computer science at Boston University. In August I'll celebrate my second wedding anniversary with Cheryl (University of Illinois '85). We just bought a two-family house in North Cambridge, and thus became homeowners and landlords all at once, after many years as tenants. Friends are watching carefully to see if my opinions suddenly change regarding Cambridge's rent-control policies."

Glenn Edelson writes: "...**Steve Edelson**, also class of '76, is no relation. I did, however, end up accidentally in an interview that was intended for him back when we were students. After a series of hardware-oriented questions that seemed off track given the emphasis in my background (artificial intelligence), I asked to see the résumé they were consulting and discovered the error."

Mike Golan lived in Phi Delta Theta and would like to track down people who lived there from 1973 to 1979. "I threw a 10-year reunion for everyone that was in the house while I was there and had 44 grads and wives show up. Nobody else has picked up the ball so it looks like I'm on the hook again in two years!" (Please send e-mail for Mike to your secretary at <quantalyt@aol.com>, and I will forward it to him.)

From **Mike Paluszek**: "After serving with Marilyn as co-president of the MIT Club of Princeton, I had a year break and then was elected VP for programs. This year we brought in a number of interesting speakers, including former Professor William Happer, former head of DOE Energy Research Pat Hanrahan, who, along with his colleagues at PIXAR, received an Academy Award in 1993 for their development of rendering software for the movies, and Professor Eugene Covert, ScD '58, of MIT. I'll be continuing in this role next year. Princeton Satellite Systems is now into its third year. The consulting part of the business is doing well with several major contracts supporting both military and commercial satellite programs. The work has ranged from designing satellite control systems to developing test plans for spacecraft flight software. We have several software products under development and our first product, a 1750A floating point emulation package, has just gone into beta test.

"I heard from classmate **Chris Roberts** recently. He started working for one of Princeton Satellite Systems' customers, CTA Space Systems, Inc., in McLean, Va., this past summer. CTA Space Systems manufactures small satellites.

ClassNotes

"Marilyn is still the department manager of music at Princeton University. Recently she was selected to chair two committees established by the central administration at Princeton to find ways to help the university work more efficiently."

From **Stephanie Orellana:** "I think that the last time I wrote was when I was in graduate school at UC/SD. I got a PhD in physiology and pharmacology there in 1987, then moved to Seattle to do a post-doc, and am now on the University of Washington faculty in pediatric nephrology. I do basic research in renal development and disease. I married Al Malouf, also UW faculty, in 1987. The first addition to our family was Burton, a Chesapeake Bay Retriever. We now also have two daughters, Alison (almost 4 years) and Kalin (5 months). Our lives are busier than ever (whose isn't?), but we're having a great time."

Ben Szaro: "I've been an assistant professor in neurobiology at the State University of New York in Albany for the past three years now. Despite budget cuts, I have an NIH grant, and several graduate students who are turning out data. Things look stable enough that I've recently bought a house, so life looks good."

Tom Downey is "now at LightStream Corp. LightStream was formed last October by merging the Ungerman-Bass and BBN engineering projects that were working on a new data communications product (based on Asynchronous Transfer Mode technology, which is not the same ATM as used by banks...). Currently I am VP for strategic business development, responsible for establishing partnerships with other companies to distribute and enhance our product. The two deals I'm most actively involved in at the moment are with Tellabs (a vendor to the Bell operating companies and other telecommunications carriers) and NEC (a large Japanese electronics company).

I'm still working on my old house, but work has made progress slow. We've been working on plaster repair and painting on one room since December (1993)!"

From **Wendy Peikes:** "The short scoop is that I am a software engineer at Gain Technology, a multimedia company providing development tools for creating sensory-rich applications. Our primary markets are computer-based training, information kiosks, and database front-ends for financial, medical, and aerospace applications. We are starting to contribute to such exciting areas as Interactive TV and the Information Superhighway. The company was aquired by Sybase in '92. We are also creating products that play well with Sybase's leading-edge client-server database technology.

"Yes, the work is exciting. I do manage other activities besides work! I live in a large house in the Cupertino foothills with three roommates, two dogs, and a cat. I love the Bay Area; it's great for hiking, bicycling, and running in the hills. It's also close to culture (even San Jose has good theatre now!) and a little further from skiing.

"I see fellow MIT-ers **Jeslie Chermak,** Diane Braken, '75, Alwin Okuna, '75, and Gary Wade, '71. Jeslie is at Mitsubishi managing the compiler group; Diane is managing an integration group at HP, and Alwin is a software engineer at HP. Gary is at Intel coordinating chip manufacturing between Santa Clara and Phoenix. Amos Oshrin, '74, lives in Cleveland and is creating expert systems for an insurance company."

In obtaining e-mail addresses, your secretary learned that **David Stork** is the chief scientist at Ricoh CRC.

As for your secretary, I remain extremely busy between trading for my own account and continuing to develop my computer business. Quantalytics is a VAR and Systems Integrator. We cover a lot of territory: telecommunications, enhanced fax technology, large scale database design (we are running one database project now, for example, with 31 gigabytes of data), imaging, and of course, networking. But the computer business has a virtue that trading and brokerage do not have—it is possible to make a client very happy with very little risk, relatively speaking.

Please continue to send news. Any news is welcome, regardless of the medium. And please send e-mail addresses!—**Arthur J. Carp,** secretary, Quantalytics, Inc., 220 Henley Rd., Woodmere, NY 11598-2523; tel. and fax: (516) 295-3230 (auto-switched); e-mail: <quantalyt@aol.com>

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Please send news for this column to: **Ninamarie Maragioglio,** secretary
P.O. Box 10315
Burke, VA 22009

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We received a few notes from the Alumni/ae Fund tear-offs this issue. . . . **Jose Flores** writes that he is practicing internal medicine and endocrinology. He is doing research on bone/mineral metabolism and positional gene mapping. . . . **Paul Haines** writes, "I moved back to Houston from Caracas, Venezuela, in January. I'm working for Geoquest—a division of Schlumberger (still). I am currently project leader for Geoshare, working on a methodology to share data between various geoscience application programs." . . . In other news, **Ed Nadler** is on the move. "My wife and daughter and I are moving to Israel, where I'll be working in CAD software development."

Finally, it is my sad duty to report the death of **Mark Altbush** in May from AIDS-related causes. Mark was a native of New York City, but remained in Boston after graduating from the 'Tute. He worked in the Boston area as a chemical engineer and was also pursuing a career as a freelance photographer. Mark is survived by his partner, Bill, and his parents Jack and Hannah Altbush of Hartford, Conn. A memorial service was held at MIT in June. Your class secretary had the pleasure of walking across the Harvard Bridge many times with Mark while at the 'Tute. He was a good man.—**Jim Bidigare,** secretary, 9095 North Street Rd. NW, Newark, OH 43055-9538, (614) 745-2676, fax: (614) 745-5648

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Lots of news this month, so sit back and relax. **Steven Holzner** wrote to me for the first time in 15 years! Steven lives in Ithaca, N.Y., to which he first moved in 1979 to get a PhD in particle physics. While a grad student, he became a columnist for *PC Magazine*, and subsequently wrote a programming book while living in the Austrian Alps. After getting the PhD, he went to work for Epson America in Los Angeles, writing computer manuals, but he hated it so he went back to writing computer books and moved to Santa Cruz. Eventually the earthquakes wore him down and he returned to Ithaca. He is now on the physics faculty at Cornell (in addition to Physics 101 and 102, he teaches Introduction to Asian Religions, having acquired a passion for Zen along the way). He makes his real living, however, from his hobby, and now has 21 computer books to his credit. They have been translated into eight languages, have been sold abroad, and have appeared on bestseller lists and with book-of-the-month clubs. He has also written a historical novel, which he expects to be published this year. His e-mail address is <sdh7@cornell.edu>, if anyone wants to drop him a line.

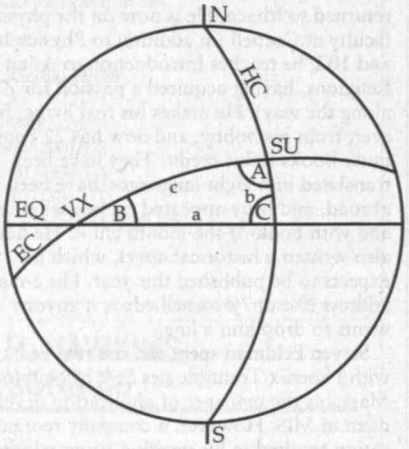
Steven Feldman spent the last two years with Phoenix Technologies Ltd. in Norwood, Mass., as the manager of application development in MIS. However, a company reorganization resulted in his position being relocated to Monterey, Calif., so Steve bid the company a fond adios and at press time was looking for another job. His wife, Debbie, is still a software engineer at Stratus Computer. Their son and daughter are 5 and 3, respectively. If you want to reach Steve on Compuserve, his account is <73773,1305> (or <73773.1305@compuserve.com> on the Internet). . . . **Marshall Burns** sent me some entertaining promotional material for him and his company, including an article about him which appeared in the *New York Times* business section last year. After graduating from MIT, Marshall founded his own company (now called Ennex Fabrication Technologies),

HAVE YOU WRITTEN TO THIS WOMAN LATELY?
Sharon Lowenheim, '79
Class Secretary

PHOTO: L. BARRY HETHERINGTON

Puzzle

Continued from Page MIT 62



The above figure represents an imaginary sphere with the Earth at its center and having projected upon it the earth's equator EQ, the poles N, S, the Sun SU, and the ecliptic EC.

The vernal equinox VX marks the transition of the Sun from south to north along the ecliptic and is a convenient reference point for locating the Sun at any time of year. The calendar date of the vernal equinox varies from year to year and must be obtained from an almanac or similar source for the year desired.

The great circle HC (hour circle) passes through the images of the Sun and the poles. Together with EQ and EC this circle forms a spherical triangle with sides a, b, and c and corresponding angles A, B, and C. For a circular orbit we may assume that the orbital speed is uniform and therefore the length of side c is directly proportional to the time elapsed since the sun's transit of VX.

It can be shown that angle B is equal to the tilt of the earth's axis. Angle C is by definition a right angle. Side b is the measure of the Sun's declination, which is the quantity to be determined.

According to the law of sines for a spherical triangle,

$$\sin b/\sin B = \sin c/\sin C$$

Since angle C is by definition a right angle, the expression reduces to:

$$\sin b = \sin B * \sin c.$$

To determine side c, we subtract the time of VX (taken from an almanac for the given year) from the desired time of year and multiply the result by the rate of change of side c per unit time.

Let T = time of year†
TVX = time of equinox transit†
Y = length of a full year†
P = angular units in a full circle (e.g., degrees)

Then c = (T-TVX)*P/Y

Since B is given as 23 degrees,
b = arcsin (sin 23 deg. * sin ((T-TVX)*P/Y)

Example:

Let T = noon GMT, April 30,1994
This converts to 119.50 days from 0:00 GMT 1/1/94.

From the *World Almanac*:
TVX = 20:28 GMT, March 20, 1994
This converts to 78.853 days from 0:00 GMT 1/1/94.

Letting angles be expressed in degrees,
P = 360
Y = 365.25 days
B = 23

Solving for b by the formula
b = arcsin (0.3907 * sin((119.50 - 78.853)*360/365.25))
= 14 deg. 34 min.

Again from the *World Almanac* (for the real earth):
Sun's declination for time T = 14 deg. 38 min.

†consistent units

Other Responders

Responses have also been received from F. Carbin, D. Detlefs, S. Feldman, M. Fountain, W. Hartford, R. Hess, M. Lindenberg, R. Moeser, K. Rosato, J. Spalding, A. Taylor, and D. Wachsman.

Proposer's Solution to Speed Problem

Glowworm, 4 u's in a row!

which he describes as "a research firm dedicated to progress in automated fabrication technologies and applications." His company produced the first of the so-called PC clones. He received a PhD in physics at the University of Texas at Austin in 1991. He has published extensively and has also been a keynote speaker at conferences around the world. . . .

Another entrepreneur, **Bengt Mutén**, has founded Mutén and Associates, which "provides strategic consulting to the railroad industry, evaluating and predicting the effects of major changes such as mergers, acquisitions, divestitures, and facilities restructuring, as well as providing the software tools for these projects." Bengt spent 14 years with DNS Associates developing transportation analysis models, eventually becoming VP in charge of their consulting practice. Bengt has an MS from the University of California/Berkeley School of Engineering.

Robert Hone is the co-author of a book called *Making Movies with Your PC*. He also was producer, director, and writer of two hour-long installments of the international PBS-BBC documentary *The Machine that Changed the World*. . . **David Band** is an astrophysicist at UC/SD studying gamma ray bursts. His wife, Debbie, is an artist and they have two sons, ages 10 and 7 . . . **John Kowalik** and his wife, Michele, are the proud parents of Grant, born in October 1993. Older brother Ross is 5 years old and "is looking forward to teaching his brother everything about Power Rangers." John still manages institutional bond portfolios for Prudential Fixed Income Advisors in Short Hills, N.J.

Andrew Weiner and his wife, Brenda, have a new daughter, Roberta Alyssa, who was born last December. Since October 1992, Andrew has been a professor of EE at Purdue, working to establish a research program in ultrafast optics and high-speed optical communications. Last fall, he canoed the Tippecanoe River in northern Indiana with **Jeff Dugal**. . . . **Shahriar Negahdaripour** has received tenure in the department of Electrical Computer Engineering at the University of Miami. . . . **Peter Bunin** has become the VP and general manager of Outokumpu Copper Kenosha in Kenosha, Wisc.

Some classmates were mentioned recently in the MIT Alumn/aei Association newsletter. **Stephanie Littell** is the president of the MIT Club of Northern California. Back at the 'Tute, **Reggie Van Lee** organized a panel entitled "Succeeding at MIT and Afterwards" as part of a Black Student/Alumni/ae Day in March. Meanwhile, **David C. Lee** set up a fax-on-demand service and a voice bulletin board to enable CAMIT members to find out about that group's activities. (For those of you who are rusty on your acronyms, CAMIT is Chinese Alumni/ae of MIT).

Some news about your Faithful Secretary. Back in 1770, Samuel Johnson referred to a second marriage as "the triumph of hope over experience." I am apparently among the hopeful, and was recently engaged to be married! More news about the event itself in future columns. Until then, keep those cards and letters coming.—**Sharon Lowenheim**, secretary, 98-30 67 Avenue, Apt. 6E, Forest Hills, NY 11374

80 15th Reunion

Just a few notes this month: **Sai B. Long** has been quiet for a few years but wrote to let us know what he's been up to. Sai has been crunching away at Exxon for eight years; the last six in Houston (where it is HOT!). He and his wife, Wendy, have two beautiful girls, Deanna (6) and Tiffany (3). "The girls keep Daddy straight and busy!" according to Sai. . . . **Charles Wilson** writes he is "surviving the bad press of *Tech Review* and other publications and Congressional budgets to move the F-22 Advanced Tactical Fighter closer to operational status." Testing starts in two years and Charles can't wait. "This plane will assure superiority over the hundreds of new planes being sold by our 'allies' around the world every year."

Through a news release we get news of **James Scutti**. James has joined Massachusetts

Materials Research, Inc., (MMR) as technical director. He will be in charge of all professional engineering at the firm. Prior to joining MMR, James worked at General Electric Aircraft Engine Division in Lynn, Mass., where he was a program manager in charge of all support for the Navy F404 fighter engines. MMR is an independent laboratory specializing in testing materials and solving failures of products involving aircraft. James lives in Arlington, Mass.

Serving the Lord: **Pamela (Hampton) Idriss** and her husband of 12 years, Samir, '81, send greetings to all their friends. This past May they left Boston to pursue Christian ministry and in-depth biblical studies full time. At the time they wrote they were waiting on the Lord for their final destination. . . . The Reverend **Samuel Nixon, Jr.**, has completed his nine-month project in the Republic of Cameroon and relocated to the Washington, D.C., area where he has assumed new responsibilities as the director of affiliate relations for the Congress of National Black Churches (CNBC), Inc.

Recruiting: The Class of 1980 is looking for a few good men and women to serve as class officers for 1995 to 2000! At our class reunion next June we will be electing a new president, VP/treasurer, secretary, and three members-at-large. In addition to these elected positions there are other opportunities to serve our class. If you are interested please let me know. You do not have to live in the Boston area or be present at the reunion to be elected and serve.

Technology Review is always looking for good quality photos of alumni/ae highlighting their activities for publication in the Class-Notes section. Let's add some interest to our notes—send your photos along with your news to: **Kim Zaugg**, secretary, 549 Fairfield Rd., Canton, MI 48188, (313) 981-1785, <vayda@erim.org>

81

As the year comes to a close, we learn that **Lisa Jungherr** is now happily married and the proud mother of a 6-month-old child. Lisa is still enjoying her career, on a part-time basis, in the medical devices industry.

Best wishes to all for the holidays.—**Mike Gerardi**, secretary, 3372 Olive St., Huntington Park, CA 90255, (213) 587-2929 (h), (310) 553-5050 (w)

82

There is not much news to report this month.

Dan Kessler is a faculty member at Johns Hopkins Hospital and attending staff at the Greater Baltimore Medical Center. He has been married to Marlene Zerden Kessler for four years. They have two cats. . . . **Aaron Rapoport**, MD, has a new position as co-director of clinical hematology services at Strong Memorial Hospital in Rochester, N.Y. He has three daughters, Julie (6), Laura (4), and Joanna (2). . . **David Kieda** and Lisa Goldstein (Wellesley '83) Kieda welcomed their second son, Zachary Adam, on June 6th. David is currently an assistant professor in the Department of Physics at the University of Utah. The Kiedas invite anyone planning on visiting Salt Lake to contact them.

Thanks for sending in info.—**Helen (Fray) Fanucci**, 502 Valley Forge Way, Campbell, CA 95008; <fangroup@aol.com>

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Our class president, **Hyun-A Park**, recently held a summer party at her house on a lake in Arlington, Mass. The food was awesome and a few class members attended as well. **Mike McConnell** was there. He is a cardiologist at Brigham and Women's Hospital in Boston. Mike and Billy Lundberg, '85, have recently started a consulting business on the side, providing competitive analysis of medical opportunities for consultants and venture capitalists. Also at the party was **Michael Goldberger**. He is the chief technical officer for Moda Systems in Kendall Square. Michael is also raising money for the company, so if any of you are or know of early stage technology investors, give Michael a call.

On a recent trip to San Francisco, I had the chance to have dinner with several classmates. **Brian Jacobs** is currently working for St. Paul Venture Capital in Minneapolis. **Mike Santullo** has set up shop in Palo Alto and is working on Internet utilities software. **Ken Krugler** and **Chris Schneider** both work for Transpac Software in San Jose, a company specializing in Macintosh applications software and localization software. **Jeff Muss** is finishing up a PhD in rocket science at Berkeley. **Kristin (Kinta) Foss** is currently living in Germany and working for Raynet, a fiber-optic switching company. Mark Farley, '84, and Lillian Chiang, '84, were also at the dinner and are both eternally grateful for being mentioned in a real class's column.

Cynthia Bedell writes that she has just finished her first year as a college teacher at the U.S. Military Academy at West Point. She also coached the alpine ski team and the novice crew teams. Cynthia says West Point is beautiful and classmates should stop by and visit if they are in the area. . . **Brenda Kitchen** writes that she is currently completing a fellowship in pediatric hematology/oncology at the National Institutes of Health. . . . **Rosalinda Hernandez-Brown** writes that she will spend this fall educating her son, Luke, at home. Her plan is that Luke will meet with other kindergarten-age children on a weekly basis in addition to Mom's personal tutoring. Rosalinda is also working on a proposal to begin a charter school for a K–8 school that emphasizes well-rounded education, including math/science/technology, character building, values, and creative studies.

Please keep those cards and letters coming.—**Jonathan M. Goldstein**, secretary, c/o TA Associates, High Street Tower, 125 High St., Suite 2500, Boston, MA 02110; fax: (617) 574-6728

84

OK, fellow class members, this month's award for longest class notes submission goes to **Robin Johnson**! "For the last three years, I've worked at SciTrek, the Science & Technology Museum of Atlanta, also known as 'Georgia's Science & Technology Adventure,' depending on whether we're writing a grant or

an ad. SciTrek is a 'hands-on' science center with exhibits and programs designed to inspire greater appreciation and understanding of science and engineering among school children and the general public. I've been director of exhibits for two and a half years. SciTrek is a young non-profit organization—five years old—so the staff work their tails off. But the work is exciting, creative, and meaningful. Any MIT grads who would like to volunteer exhibit ideas, technological demonstrations, or other talents, please call, (404) 522-5500 x236.". . . **Steven Larky** writes, "My wife, Alexis (Wellesley '84), and I are the proud parents of a baby boy, our first child, Joshua Ben, born April 24, 1994, 8 pounds 14 ounces. As if that weren't enough change in our lives, I've also changed jobs and am now at Brooktree in their Austin, Tex., design center working on multimedia chips. Some things that haven't changed: we haven't moved and are still enjoying life in Austin, Tex." . . . **Phil Kaaret** says, "In 1989, I received a PhD in physics from Princeton. In 1990, I became an assistant professor of physics at Columbia. In 1992, I married Amy Luttinger, '81. And in 1994, on May 11, Amy and I had a son, Alexander Lionel. The three of us currently live in Manhattan.". . . **Tony Riccobono** is now a proud father. Daniel Anthony was born April 26, 1994. "My wife, Donna, and I will never sleep again!" he laments. Tony is currently a field applications engineer for Synopsys.

Along with news of birth comes, unfortunately, notice of a death. I am sorry to report the passing away of **Lisa Sugarman**, who died on February 2, 1994. Lisa had most recently made her home in Kaneohe, Hawaii. She will be missed by all her friends, especially her fellow members of Fenway House.

Some '84ers just can't get enough school. After getting an SB in 1984 (electrical engineering), and an SM and EE in 1991 (electrical engineering and computer science), **William Chiarchiaro II** is back for more, working his way through the part-time MBA program at Babson College. He has also been volunteering with We are AWARE, a charitable organization providing self-defense education and training for women. . . . **Brigitta Brott**, MD, is currently in the final year of an interventional cardiology fellowship at Duke Medical Center. About two years ago, she married Bill Hillegass, MD, who is in the same program. . . . **Kim Carlyle Coldwell Worley** just earned a PhD in molecular genetics from Baylor College of Medicine. (They actually put out a press release. That's impressive!)

Your eminently trustworthy and loyal secretary just got back from a two-week trip to Alaska, the Yukon, and the Northwest Territories, accompanied by none other than the perpetually peripatetic **Wendy Keilin**. We made it all the way to the Arctic Ocean (warm and not salty!) where we saw the edge of the Polar Ice Cap and learned about native culture (they're called aborigines there, too). Down at the dock in Valdez (Alaska), the fish were so plentiful that people were giving away fresh-caught four-pound pink salmon. We had quite a feast! The wildlife we saw included black bear, moose, sea otter, sea lion, bald eagle, beluga whale, and mosquito. . . . Finally, **Joe Schmendrick** sent me an e-mail message: "I'm off to Africa on a safari to search for a rarely-seen species of white elephant—yes, they apparently *do* exist! I'll send you photos." . . . Remember, without *you*, there is no Class of '84 column. So keep the news coming.—**Jonathan Miller**, secretary, 78 Roosevelt Circle, Palo Alto, CA 94306, (415) 494-7430, fax: (415) 813-1130, e-mail: jonathan_miller@logitech.com.

85 10th Reunion

Greetings. First the weather. It may be hard to believe, but on the day I wrote this column it was 87° F and humid in Pittsburgh. And now the news.

Ray Henry writes: "I have been at the Texaco Research Center in Beacon, N.Y., for six years. I'm in computer services, writing lab information systems, etc., using Oracle and Visual Basic. Brandy and I will be celebrating our 10th wedding anniversary(!) in December. We recently bought a home in Fishkill, N.Y., and moved in on June 18th."

Barry McQuain reports on lots of activity by classmates. "**Chris Yu** got married in N.Y.C. at the end of May to Anna Kwaung, '89. Lots of MIT'ers, including **David Roberts**, **David Douglas**, **Val Mihan**, **Jens Legalet**, **Noelle Merritt**, and more. Also, **Tom St. Louis** married Mary Powell that same weekend in Connecticut. In addition to the above, **Steve Roe** and **Tim McKenney** were present. Good times for all. David Roberts recently moved out here to Aspen, Colo., to start Forest Software, concentrating on developing software for the Newton MessagePad. As for me, I'm still a money manager out here in Aspen, Colo. We've managed to climb two 14,000-foot mountains so far this summer, and have one ice climb planned for November."

Tom Davis reports that he is still a "SPaMster" with Hewlett-Packard in Palo Alto. In his spare time he is tutoring at the local high school, and he is serving on one of HP's philanthropy committees. He is also cycling and running a bunch. Last year he managed to cover five passes in the infamous "Death Ride." If he can get enough pool time he will do another triathlon.

Tobe Barksdale was married on April 16 to Linda Graham with several alumni/ae in attendence: **William Stanback**, **Ismael Rodriquez**, **Pamela Givens**, **Andrew Bennett** and wife Joice Himawan, '83, and James Scanlon, '91. Currently he is having fun as an EE at Bose Corp. and is living in Bolton, Mass.

Gymnast **Bill Maimone** married Leslie Durboraw in June 1993. Other MIT gymnast alums present for the event were Richard Campione, '86, Dave Wilson, '86, Brian Hirano, and Jason Kipnis, '88. By coincidence all except Jason married in an 11-month period. Leslie and Bill started round two with the birth of Marissa Catherine on May 1, 1994. Bill is still working as a group manager in database development at Oracle.

Send news to: **Bill Messner**, 5927 Alder St., Pittsburgh, PA, 15232; (412) 362-4180: Internet: <bmessner@andrew.cmu.edu>, listserv: <mit1985@mitvma.mit.edu>

86

First of all, I'd like to take this opportunity to thank **Mary C. Engebreth** for her stewardship over Class Notes for the past eight years. That's a lot of monthly columns, and we

greatly appreciate her service as class secretary.

Tom McKendree informs us that he was married on March 5 to Ursula Knopp in southern California. The reception was held right across the street from the hotel where the couple first met. After the wedding and honeymoon, Tom started work at Hughes Systems Sector in the Advanced Systems Development organization. . . . Another classmate, **Geoff Engelstein**, was unable to make the trek out to the West Coast for the wedding, seeing as how on March 7 his wife, Susan, gave birth to their first child, Brian Noah. Tom also passed along news about the wedding of Carlos Montero-Luque, '87, who married DeAnn Elliott on February 20. Following a Spanish tradition, Carlos's mother was matron of honor, and DeAnn's father was best man. Among the ushers were **Ed Humphrey**, Geoff, and Tom. Carlos is now working for Open Environment Corporation, leading their QA efforts. . . . **Edison Wong** is entering his last year of residency training in the specialty of physical medicine and rehabilitation at the University of Washington in Seattle. He expects to finish in June 1995 and anticipates moving back to the Northeast, depending on the job outlook. He's on-line at <worlord@u.washington.edu>.

Jim Russell is still working at IBM's Watson Research Center in New York, and reports that he and wife Susan just had a baby boy, John Blodgett, on June 30. He and Sue haven't gotten much sleep lately, but they're still excited about the baby. . . . **James Person** reports from San Diego that he and his wife, **Suzanne (Dunbar) Person** have both been travelling in their jobs at QUALCOMM, Inc. Suzanne is in the CDMA cellular and PCS international marketing department, and James was recently promoted to senior program manager in the Globalstar satellite telephone group. James's recent trip to Paris was relatively non-eventful, but Suzanne's trip to Bombay, India, seems to come straight out of an Indiana Jones movie. Suzanne was in the back of a taxi en route from the airport to her hotel (in the middle of a monsoon), when the taxi and another car (full of men) sideswiped each other. After a heated discussion between the drivers, her taxi was surrounded by the other group of men, who rocked the car back and forth, and started kicking in the trunk, hood, and sides of the car. Suzanne's cab driver managed to drive away, but then a chase ensued. Eventually, the taxi was able to shake the tail and make it to the hotel safely. Whew! . . . **Scott Berkenblit** writes that he is finally finishing a PhD this summer at MIT (in the HST program). In September, he returns to the clinics to finish up his last two years of medical school. He's managed to remain active in the MIT Concert Band and other musical groups while in grad school, but he's not sure how much longer that will last.

For those who haven't been keeping up with **Wade Shimoda**, he left the Air Force in 1990 to go to business school at the University of Rochester. He got married in 1991 to Lori Nakayama, who is also from Hawaii. Now he's working in Vermont for Central Vermont Public Service Corp., the state's largest electric utility, evaluating energy conservation programs and doing marketing research. If anyone is visiting Middlebury, Vt., please give him a call. . . . As for me, your new class secretary, I'm working for Cognex Corp. in Needham, Mass., as a marketing manager for a new generation of machine vision systems used to automatically inspect parts in manufacturing processes. My travels to Singapore and Korea back in May were fairly calm, but I did learn that a lot of Singaporeans genuinely felt the caning sentence for Michael Fay was unusually harsh. Submissions to Class Notes via e-mail are encouraged.—**Bill Hobbib**, secretary, 5 Cappy Circle, West Newton, MA 02165, <hobbib@cognex.com>

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87

Greetings from sunny, humid South Carolina! The first news tidbit this month comes from **Jerry Barnes**, who is a senior engineer for Raque Food Systems in Louisville, Ky. Jerry's job sounds like fun, as he spent time this year installing automated pizza lines in both Spain and Ireland. In addition, Jerry reports that he plays lead guitar for the company band. He's been married for eight years as of this July, and currently has three wonderful daughters.

Returning to the mainland from her home in Hawaii is **Molly Kihara**, who has traded the warm people and weather of the islands for

her quest for knowledge. Molly has just entered UCLA's doctoral program in environmental science and engineering, and finds that her greatest challenge is trying to get around LA without a car. She's getting better—she even succeeded in catching the bus to the DMV! Molly is interested in the whereabouts of classmate **Janet Lee**.

Also rejoining us on the Mainland is **Jerry Hershkowitz**, who has just returned to Austin, Texas, from his seven-month overseas assignment with Motorola in Munich, Germany. He wishes that he could have stretched it another couple of months so that he could have been there for Oktoberfest. Jerry reports that his two years of MIT German classes helped a great deal while there, and also had the opportunity to add some Czech to his repertoire of languages with the help of his Czech friends. While in Munich, **Tom Abell** stopped by during his post-graduation (MIT Leaders for Manufacturing)/pre-job (HP in California) trip, where Jerry did his best to introduce Tom and his traveling friends to the Munich specialties of weissbier and weisswurst.

Just over the border (I think) from Germany, the news from Switzerland this summer is actually pretty tiny. Weighing in at 3 kilos and 49 centimeters is Amelie Kim, daughter of Estelle and **Patrick Kim**. Patrick says that Amelie is a very lucky baby, as she had a view of both the Lake of Geneva and Mont Blanc from the 5th floor nursery of the hospital in Morges (between Geneva and Lausanne). Estelle is doing pretty well, and all of them are slowly becoming used to the details of family life. The Kims' main hobby is still their vegetable garden, where they have found that the varieties of North American squash and tomatoes that they planted just love European soil! Patrick's brother Eric Kim, SM '93, just got a job in Paris with Monitor, which means that he will be close enough to "actively uncle..."

Jeff Klohr has been busy over the past few months. In addition to working for McDonnell Douglas in St. Louis, Jeff has recently completed a two-month Berlitz program in German, and is now "theoretically somewhat fluent..." To try out his language skills, he took a two week trip to Europe last February with his girlfriend, where he was able to get together with a number of German friends. This summer brought a trip to the World Cup Soccer Games, first in D.C. with **Maria Kozlowski** and **Ed Savard**, and then in San Francisco with T.J. Cradick, '88, **Susan (Fields) Baily**, and the rest of the MIT/Stanford grad-student crowd. Finally, Jeff is in the process of buying a house in the University City area of St. Louis —a brick, two-story, 3-bedroom, hardwood-floor house with a ceramic roof that has just been rehabbed.

Neal Hoyer, as recently reported, has moved from the wonderful world of surgical staplers to Ford, where he is working in Powertrain Operations on the design and analysis of engine blocks. He's been traveling around a bit for the past few months in his Fine New Ford Product: visiting Charleston, S.C., St. Louis (where he went to grad school), and New Jersey. Over the July 4th weekend, I had the opportunity to visit Neal and some of his friends from Cincinnati on the Outer Banks of North Carolina. Currently, Neal is getting settled in his new house in Berkley, Mich., and getting ready for ski season (smaller hills mean more runs per day!).

Neal included New Jersey in his trip primarily to attend the wedding of **Adam Kane**, who married Robin Bialer, a fellow AT&T Federal Systems employee. They met about four years ago at a departmental Christmas party that Adam "crashed" two days after Robin transferred to Whippany, and were engaged last December 23rd. The wedding was held on May 22nd at the Marlboro Jewish Center (in Marlboro, N.J.), and provided the locale for a mini Burton 5 reunion with **Dave** and **Pam Graham**, Amy and Larry Candell, '88 (married the following week in Cambridge), the aforementioned Neal Hoyer (an honorary Burton 5 resident), Angeline and Chan Lin, '88, and Geeta ('88) and **Achie Aggarwal** (who just bought a new house in Worcester, Mass.) all attending. Adam and Robin took a delayed honeymoon cruise to Alaska, Vancouver, and Seattle this past July. The couple is living in Morristown, a short five-mile commute to work. Workwise, Adam recently transferred to the Network Systems division of AT&T, where he is working on phone protection. No, this is not the practice of Safe Phone, but Central Office lightning and surge protection, so that your kitchen phone does not blow off your wall during an electrical storm.

Briefly . . . **Sang-Wook Yoon** has graduated from Yale's MD/PhD program this past June. He is now doing an orthopedic surgery residency at UC/SF. . . . **Simson Garfinkel**'s book, *The UNIXHATER's Handbook*, co-written with Daniel Weise, '86, and Steven Strassmann, '84, has now officially been published, and should be available at a bookstore near you. It comes with its own official UNIX barf-bag, and has a foreword by Donald Norman, '57, and an "anti-foreword" by Dennis Ritchie, the "father" of UNIX. Simson is marrying Beth Rosenberg this October 16th. . . . **Kim Chasteen** reports that she and Doug went to Atlanta this past summer to participate in an attempt to break the Georgia state skydiving record. Unfortunately, they were unsuccessful in their attempt to build a formation of 44 people. Sounds exciting, nonetheless...

Have a great Holiday Season!—**Jack Leifer**, secretary, 2908 Roses Run, Aiken, SC 29803; home: (803) 642-3900, fax: (803) 642-2700, work: (803) 648-6851; e-mail: <leifer@ccwf.cc.utexas.edu> or <MIT1987@mitvma.mit.edu>

88

I recently found myself giving a tour of MIT to an out-of-town guest and decided to update you on some of the changes around campus. The new and very modern biology building is completed and open. It stands tall across the street from building E18 and E19. Lobdell now serves food from Burger King and Pizza Hut and Toscanini's Ice Cream is just downstairs in the Student Center. Athena now has Sun SparcStations among other assorted high-end computing machinery. And finally, the library card, meal card, and student ID have been combined into one ID complete with a digital picture.

Susan Lee graduated from Cornell this August with a PhD in mathematics. She'll go

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to UC/SD next fall as a postdoc. . . . **Andrea Schievella** got a PhD in biology from Harvard and is working as a postdoc at the Genetics Institute in Cambridge. Andrea is enjoying her work, studying the biological basis of inflammation. She is currently living in Winchester with her husband, Bob Karp, '82.

Peter Gasparini married Linda Dahl last February. Sig Ep pledge brothers in attendance included **Mark Carroll, Pete Blayney, Taylor Boon, Joe DiSabato, Ken Fujimoto, Ken Westlund, Jon Brandner, Dave Schmidt, Stu Olmsted, Dan Pugh, Dave Moe, Dave Dahlke, Lieven VanMarcke,** and **Satish Lathi.** After 12 years, **Gina Gonzalez** will be marrying Brian Rague, '84, SM '87, on November 23rd. They have a 7-year-old son, Justin, and new baby girl, Maria Jeanne. They are both at JPL and also own and operate a growing network business.

Reggie Tucker and his wife, Carol Goldsberry Tucker, who is an alumna of Brown University (BS '87, biomedical engineering) just gave birth to their first child. Sydney Elizabeth was born Friday, May 20, 1994 (7 lbs. 2 oz., 19.5 inches). Reggie is currently working for Hewlett-Packard in Andover, Mass., in the Medical Products Group. He is a manufacturing development engineer responsible for transesophageal ultrasound imaging probes for the heart and has found HP to be both challenging and fun. Other classmates at HP include **Marc Filerman, Sharon Gadonnieux,** and **Linda Ystueta.** Outside of work Reggie is busy with squash, working out, and involvement in professional organizations such as the National Society of Black Engineers. He is also spending a lot of time at MIT mentoring and tutoring students, serving as a member of the MIT Corporation, and serving on several committees of the Corporation.

James Gill married Raffaella Morotti in Litchfield, Conn. James graduated from University of Connecticut School of Medicine and is a second-year pathology resident at Yale, New Haven Hospital. Raffaella is a graduate of Liceo Claddico of Bergamo, Italy, and University of Milan Medical School. She is also a pathology resident at Yale.

Paul Anderson and **Gail (Sadlo) Anderson** plunged into the American Dream of home ownership in a quiet suburb of Philadelphia. Gail writes that her experience with Habitat for Humanity will be very useful since their new home is a "handyman's dream." Paul works at Crane ChemPump. Gail left her job working on the 777 at Boeing for a new occupation. She is now assistant director at a Crisis Pregnancy Center, a ministry of local churches that reaches out to young pregnant women. Other alums in the area include Anne (Tuttle, '89) and Bryant Ling, and Sue (Kuhn, '89) and **Phil DiMascio.** Mark and **Livia (Zien) Jacunski,** currently residing in Virginia, visited the Andersons. In June, Gail and Paul attended the wedding of Jinny (Kim, '91) and Adam Szabo, PhD '93, along with several other UCFers: Lorelei (De Gala, '91) and **Chiu-Oan Ngooi,** Brian Miller, '90, **Diane Di Massa,** the Lings and the DiMascios, and Cathy (Trotter, '89) and Kevin Wilson (a PhD student at MIT).

David Saslav recently got a new neighbor, Zakia Zerhouni, SM '94, at Oracle (Redwood Shores, Calif.). At MIT, Zakia did all her work at the AI Lab for Patrick Winston, '65, for whom David had worked while at Ascent Technology. David is currently in a singing group with Kris Kelly and her husband, **Arthur Gleckler,** who also once worked at the AI Lab. One of David's singing groups, the SF Bach Choir, is also attended by Noam Chomsky's son Harry. They are giving a concert in July which includes the Mozart Requiem performed on stage at SF's Davies Symphony Hall where the SF Symphony Orchestra plays!

Ed Koshimoto received a master's degree from the University of Michigan in aerospace engineering. Ed is currently working at the Kennedy Space Center for NASA as a payloads fluids system engineer. Ed is enjoying Florida and the water around it, but in the winter he misses the snow.

I hope you all have a wonderful holiday season, and send in some holiday Class News!—**Catherine Singer,** secretary, 131 Main St., Andover, MA 01810; <singer@mit.edu>

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The Class of '89 e-mail list has grown over 50 percent since last month, so if you are interested in being on the list, please e-mail me at the address below. Also, the Class of '89 World Wide Web site is up; it has pictures from the reunion, information about class offices, information on our class scholarship, a list of '89ers with web pages, and more. Any suggestions for additional information will be welcomed! The URL is: <http://tns-www.lcs.mit.edu/mit89/>

Here is this month's list of people to please write in: **Susmitha Bellam, Nirag Dube, Mark Lubratt, Leanne Sterbank,** and **Felice Yeh.** What are y'all up to? If anyone knows about any of these people or anyone else, please write in!

Jolly Chen was married on June 18th to Elizabeth Shieh (UCLA '91). Jolly writes that "A bunch of MITers were at the wedding. My best man was **Jason Nieh.** Other MIT alumni/ae in attendance included **Curtis Eubanks** (and his wife, Tina), Curtis Chen, '91, Chester Loh, '90, Ernest Prabhakar, '88, Sam Kho, '92, Stephanie Choo, '93, Todd Weigandt, '91, Gene Sohn, '92, and Robert Yokota, '88. Liz and I had a fun honeymoon going up the coast of Northern California to bed & breakfast inns, and then going to the Orient for 10 days to see relatives and friends. Marriage is great. I highly recommend it!" Jolly is still plugging away at a CS PhD at Berkeley. "Now that I'm married, I have more incentive to get out and get a job, instead of dilly-dallying in grad school," Jolly writes.

In June, a bunch of **John Araki**'s old gang got together in Chicago to attend the opening match of the World Cup. Present were John, **Dean Chang, Greg Ritchie, Eric Eileraas, Tomas Saulys, Ed Flynn,** and **Mark Olson,** whose place they invaded. **Andy Barrrows** also happened to be driving through Chicago that weekend. John writes that "It was comforting (and maybe a bit scary) to discover that despite the years and distance, not a whole heck of a lot had changed when everyone got together."

In July, Mark and John made a spontaneous trip to attend the World Cup final at the Rose Bowl, fulfilling a pact they had made several years ago. John and Mark stayed with **Patrick Goshtigian** and his wife, Christina, who live in Beverly Hills. "Yes, their zipcode is 90210," John continues. "The game itself was an awesome experience. For a soccer fan, I don't think it could get any better than that."

John has been "working in the Fixed Income Sales and Trading group at CS First Boston in New York for the past two years or so. I am currently involved with the structuring and trading of bonds backed by commercial mortgages. The best part of my job is that it gives me access to e-mail, which lets me keep in almost daily contact with Dean and Andy at Stanford, as well as **Ben deSousa** in Boston."

Ben graduated from BU in May with a master's in film, and writes that "This summer I was a cinematographer on a documentary filmed in Ecuador from July 4 to July 20. It was with the same crew that filmed in Greenland in the spring. We stayed part of the time in the capital, Quito, almost two miles high in the Andes mountains. We also spent some

time in other small mountain villages, as well as about a week in the rain forest. The weather in the mountains was cool, in the 60s and 70s. In the rain forest it got quite hot and steamy, but it was never unbearable. It just seemed even hotter because we wore long sleeve shirts and pants to avoid insect bites.

"The subject of the film was a semi-isolated community of Black South Americans who have maintained their African culture despite not really knowing about their ancestry, nor how they arrived in Ecuador. The film was shot in 16mm, and will hopefully be edited into a 30-minute piece to be shown on public television some time next year," Ben concludes.

Jean Kim is in Northern California working for a subsidiary of TRW and had a chance to visit the East Coast this summer to attend various weddings, one of which was the June wedding of **Marcia Smith** and Stephen Smoot, '90. Jean writes that "Yes, the Son of Smoot is a married man. The wedding and reception were at Marcia's parents' house in Geneva, N.Y. It rained for days before the wedding and cleared up that morning. It was a beautiful day for a wedding. Then, as the reception started to slow down and guests began to leave, it started to rain again. Perfect, eh? There were lots of MITers and, of course, lots of the Smoot clan. There were lots of people from East Campus there, as well as **C. J. Mallion**, Duffy (Craven) O'Craven, '85, Kathy (O'Connell) O'Craven, '87, A. J. Babineau, '90, who was the maid of honor, and Oliver Smoot, '62.

"For July 4th, **Ron Koo**, **Stephen Malinak**, and my husband and I got together and watched the fireworks from the grassy knoll near the Shoreline Amphitheatre," Jean continues. "Oh, and in May, **Julia Hsieh** and Mike Bernard, '85, got married in L.A. I saw **Jill (Wilkens) Angle**, Judy Yanowitz, '91, John ('88) and **Ann Mailhot**, Bill Coderre, '86, and lots more MITers I didn't know including the best man. Oh, well. Other than the structural failure of the wedding cake holder (consequently, the top part of the three-layer wedding cake fell over before the reception started!), the wedding and reception went smoothly."

On Jean's July trip out to the wrong coast for a family wedding, "I got to visit Ann (Herrman) and John Mailhot and their cat, Toscii, at their home in Somerville, N.J. Ann is with child (their first) and is due in January. Ann is hoping for just one child since twins run in her family! John is still working for AT&T Bell Labs and is shuttling between Washington, D.C., and home."

Karen Lewis is currently living in Boulder, Colo., working as a graduate student at the University of Colorado. "I've switched from math to glaciology, which is far more fun, and will be going down to Antarctica for two and a half months this year (October to January) to do field work in the Dry Valleys across from McMurdo Sound."

Bhavya Lal followed up an SM in nuclear engineering with a master's in technology and policy at MIT's Technology and Policy Program. "I got married to Lukas Ruecker, '88, in 1993 and after a brief stint at MIT's PhD program in nuclear engineering joined Abt Associates at the Center for Science and Technology Policy Studies. I am also in the international health and economic development area and looking forward to traveling abroad," Bhavya writes.

Anthony Schinella writes that he "has completed his graduate work at Starfleet Academy, and has been acquitted of that spice-smuggling charge." Anthony is "presently stationed at Starbase Six, but hopes to return to his home on Proxima Centaurii soon."

Mark Moss pinned on his captain's bars on May 1st, and in January 1995 will be going to Fort Gordon, Ga., with the Signal Officer Advanced Course before going on to graduate school. "Be it Stanford or the 'Tute, keep your fingers crossed for me!"

Well, that's it again for this month. There are still some calendars left for those of you who would like to contribute voluntary class dues! Thanks, and please send photos for next year's calendar (we'll even accept GIF or any electronic file format for photos)!—**Henry Houh**, secretary, 4 Ames St., Cambridge, MA 02142; phone: (617) 225-6680, fax: (617) 253-2673; e-mail: <hhh@mit.edu> or <henry_houh@mit.edu>, World Wide Web URL: <http://tns-www.lcs.mit.edu/mit89/>

90 5th Reunion

After working as an investment banker on Wall Street and a government executive in the Virgin Islands, **Michael Dixon** is now back in banking as a municipal investment banker in Dallas. He also was recently married and is the proud father of an 8-month-old-boy, Tarik, with another baby due soon! Anyone wishing to get in touch can e-mail Michael at <MD514@aol.com>. . . . **J. Dora Schaefer** is currently pursuing a PhD in biomedical engineering at Johns Hopkins University. . . . **Joanne Spetz** is finishing up a PhD in health economics at Stanford. . . . **Erica Kuo** is now studying at the Stanford Law School. . . . **Humphrey Chen** has just left Morgan Stanley to pursue an MBA at the Harvard Business School.

Su Varadarajan is leaving GTE in Dallas for the Wharton Business School. . . . Also back in school is **Amos Leung**. Amos is in the master's in manufacturing management program at the Kellogg School at Northwestern University. (Isn't this the Sloan LFM wannabe program?) Amos also writes that back in March, he and his roommate from Burton House, Se-Wai Lee ('92), traveled to France and Switzerland. They went to the Geneva Auto Show and visited with **Lisa Lozo**, who is living on the French Riviera while on foreign assignment with medical equipment supplier Cordis. It's rumored that Lisa's French has definitely progressed beyond Au Bon Pain! Amos was best man at Se-Wai's wedding in Boston. Also at the wedding was **Renata Pomponi**, who is working on a PhD in MIT's technology and public policy (TPP) program after completing work on a master's degree in aero/astro and TPP.

On June 18, **Raquel D'Oyen** married Michael Drout. They met when they were both at Stanford working on master's degrees. They are now in Chicago, where Raquel is pursuing a PhD in materials science and engineering at Northwestern University and Michael is working on a PhD in olde english at Loyola University. Maid of honor was **Maureen Fahey**, who is now working for 3M in Austin, Tex., after receiving a PhD in mate-

'89 WEDS '90: *Rick Franklin, '89 married Cindy Shen, '90, in May. MITers standing, from left, are Brett Vanderlaan, '90, Jessica Hirschfelder, '89, K. Dindorf, '89, and his wife, Debbie, Ryo Shiono, '89, Gigi Hamad, '89, Terry Fong, '89, Kirsten Domingo, '90, Steve Soares, '85, Lori Fretz, '90, Richard Elder, '89, Mary O'Donnell, '90, Kai-Yee Ho, '89, Joanne Spetz, '90, Zain Saidin, '89, Heather Goo, '91, Chris Neils, '89, and his wife, Julie, Ellen Shen, '91, Jen Lloyd, '89, Stacy Rogers, '89, Beth Fellingham, '89, and S. Wang, '89.*

New Grad Helps Nab Portland Murderer

Andrew Dickson graduated last May with an SB and SM in electrical engineering and computer science and is now working in Portland, Ore. In an e-mail message to Roland Allen, associate director of admissions at MIT, Dickson reported risking his own life to help apprehend a murderer, and Allen passed the tale on to the Review. *We print a slightly edited version below.—Ed.*

Hello folks,

I just wanted to tell people about something that happened to me [in early August]. I don't think it'll get on national news, but it was front page in the newspaper here in Portland.

A man from Vancouver, Wash., came down and robbed our neighborhood Safeway at 10:20 p.m. I drove into the parking lot and heard a gunshot or two right in front of my car, and I saw a lady fall down [dead] and a guy turn and run away to his car, which was also right in front of my car.

He pulled away and I began to follow him out of the parking lot and onto a little side street, trying to memorize the plate number. About two blocks later, he made another right turn onto another residential street. Halfway down that street, I saw his brake lights go on, and he got out of his car, and the next thing I know, a shot rips through my window and into the passenger seat next to me.

I slammed on the brakes, ducked down, and put the car in reverse as fast as I could. Two more shots hit my car—one of which fragmented inside the car, the other went through two seats and exited out the back of the car, still going fairly fast. I was really scared for my life. [When] he got into his car again and drove away, I got out of my car, ran to the nearest house with the lights on, and called 911.

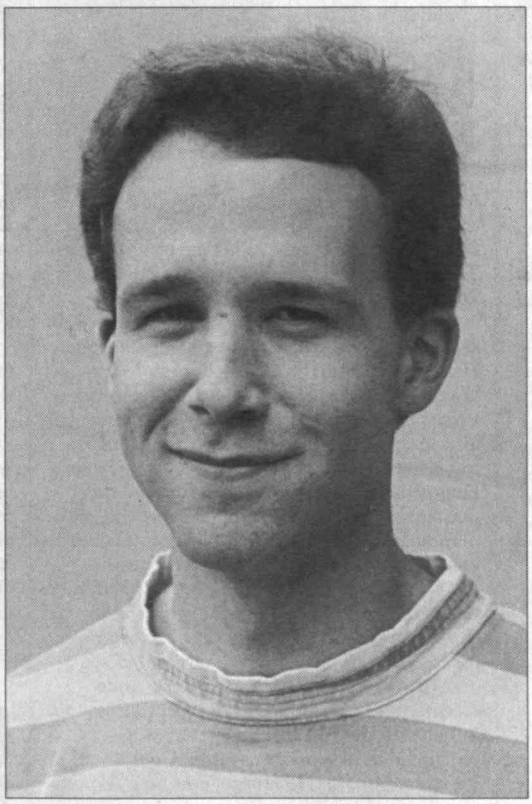
The police showed up really quick, and I gave them the license number and all the details. The man was driving his own car and went back to his own house (no one ever said that criminals had to be smart). Later that morning, the SWAT team surrounded his house, and he surrendered. He is 28 years old, and he was still on probation for robbing a bank down in California in 1990.

The lady that he killed here was a 55-year-old woman who apparently didn't even try to confront him at all. She was an innocent bystander. I was pretty shaken up, but it really hit home with me last night when the daughter of the lady called me up at home to say thank you. The [victim] had worked at a nearby hospital, where everyone referred to her as another Mother Teresa. She gave up a lot of her time to help the homeless and to work with Northwest Medical Teams—an organization that does short-term medical missions in foreign countries, I believe.

The whole thing still doesn't seem real to me. Our neighborhood here is a "Leave it to Beaver" neighborhood—totally safe, old, very quite, nice houses. It took just one man to turn it upside down!

It made front-page news today and was on four different TV news channels last night. Three of the stations came out to where I work and interviewed me, and the last one came to my house after work. I'm living with four guys from church, [and since we] didn't feel like cooking, two of us went to get some pizza. When we came back, *News 8* was already set up (tripod, camera, lights, etc.) in our living room, waiting! They were all really nice about it.

I'm doing okay. My car is a little worse for the wear, but that's all right, I can do without it for a while. A bit too much publicity for me too. It's kinda fun having people you've never met before come up to you, shake your hand, and ask lots of questions, but it's a bit much after a while. I'd like to return to normal-person status again. □



ANDREW DICKSON, '94

PHOTO: THE *OREGONIAN*

rials science and engineering from MIT.

Cindy Shen married Rick Franklin ('89) on May 27 in Maryland. It was a beautiful wedding, complete with an Air Force Honor Guard and followed by a Chinese banquet. Cindy and Rick honeymooned in Jamaica before Rick took off for advanced training with the Air Force in Oklahoma and Cindy started her residency in pediatrics at St. Christopher's in Philadelphia. At Cindy and Rick's wedding was **Mary O'Donnell**, who just graduated from the Einstein Medical School. After a whitewater rafting trip in Idaho, Mary will begin a residency training in internal medicine at Columbia Presbyterian in New York City, as will **Margaret Tawadros**, who just graduated from the New York University Medical School.

Kirsten Domingo is working as a traffic engineer in Boston and will be married in November to Steve Soares ('85). . . . **Ellen Case** has been working for an environmental law firm in Washington, D.C., after graduating from the Georgetown School of Law last year. . . . **Brett Vanderlaan** has been teaching high-school chemistry and physics in Washington, D.C., and plans to attend graduate school for music composition. . . . **Lori Fretz** is working in Florida as a civilian engineer for the Navy, and in her spare time she's enjoying scuba diving and getting a great tan! . . . **Zain Saidinz** is a computer engineer in Silicon Valley. . . . **Greg Gould** is working at Goldman Sachs in New York City, and I just started a new job at American Management Systems in Redwood Shores, Calif.

That's it for this time! Please send news, and if you are interested in helping with our 5th Reunion, let me know.—**Ning Peng**, secretary, 2157 El Capitan Ave., Santa Clara, CA 95050

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"I followed my brass rat west to San Francisco," writes **Michele Monclova**, who works for a small software consulting firm and enjoys rollerblading along San Francisco's hills. . . . **Kelly McDonald** began work at RSSI, a computer consulting firm specializing in rapid prototyping and client/server technology. "It's much more technical," she writes, "and lots of fun, due to some great travel destinations. I plan to vacation this year in Indonesia in an attempt to one-up last year's sailing trip from the Virgin Islands to North Carolina." Kelly says she enjoys keeping up with her fellow Student House alumni/ae. . . . **Robyn Jaloszynski** writes that she was recently engaged to **John Gilbert**. They both began work for Procter & Gamble at the end of the summer.

Peter Stewart married Melissa Schulz in August in Brooklyn, N.Y. . . . A photograph of **Judy Yanowitz** using a microscope at the Woods Hole Institute appeared on the front page of the *Boston Globe* in July. The corresponding article about the Institute said that Judy is now at Princeton University and quoted her as saying, "To wonder about what's going on inside the cell is to ask, 'What is life?'". . . **Paschal Stewart** visited Boston in July with his fiancée, Carol McKay (UNC). Paschal is in his fourth year of medical school at Bowman Gray, and Carol is a middle grades social studies teacher. . . . **Donna Khodarahmi** was engaged to Chris Wren, '93. Chris started his graduate work at MIT in computer science this fall. Donna plans to graduate from the University of Pennsylvania medical school in May and hopes to start a pediatrics residency in Boston.

Steve Atkins is studying for a PhD at MIT. Steve visited with **King Chan** on a recent vacation to Australia. King will be at Harvard Business School in the fall. . . . **Lynore Abbot** completed an organic chemistry course at Boston University this summer, and writes, "The non-chemist is finally learning chemistry!" . . . **Susanne Perutz** passed both qualifying exams en route to obtaining a PhD in materials at Cornell. Her project is to create a self-healing, low-energy surface for the hulls of Navy ships so that the barnacles won't stick to the hulls. In summertime, she enjoys swimming in the cooling gorges, sometimes joined by **Laura Beecroft**. . . . **Andrew Alleman** received a master's degree from the University of Washington and is now working in Portland in the telecommunications industry.

Lee Heavner is in his second year at the University of Chicago where he is pursuing a PhD in business economics. Lee writes that **Luis Espinoza** has been working for Intel in Albuquerque and that **Jonathan Clapp** is working for an environmental engineering consulting firm in Pasadena, where he enjoys rollerblading.

Please send a letter or postcard with the latest news.—**Andrew Strehle**, secretary, 59 Commonwealth Ave., Apt. 4R, Boston, MA 02116

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Please send news for this column to:
Leslie Barnett, secretary
56 Brown St.
Mineola, NY 11501

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Hello! And happy holidays to all! What a year it has been here in New England. Snow, snow, and more snow, no spring and a sweltering summer. Now it's time to buckle down for Old Man Winter once again. Just a reminder to keep those class notes pouring in! For our next issue I'd like to hear from the following people: **Jeroen Timmermans, Melanie Rodriguez, Stephanie Spenser**, and **Amir R. Amir**.

Let's start with engagements. **Bob Rockwell** and Heidi Goo, '92, became engaged in June. Heidi is attending medical school in Maryland, and Bob is getting a master's from University of Virginia. . . . **Natasha Terminassi** is also in the same program as Bob. **Alicia Gruber** also recently became engaged. . . . **Carrie Huguenin** and **Claude Denton** finished their master's degrees at MIT and became engaged.

In Boston I ran into **Beth Foch** on the No. 1 bus. She was on her way to bartend at the Miracle of Science bar. . . . I also saw **Karen Lee** in the Longwood Medical area. I believe she is doing research at Children's Hospital for the summer. She will be starting her second year in HST this fall. . . . **Mark Aude** recently rejoined the ranks of '93ers in Boston. In February he left Paradigm Design in Philadelphia to work for Design Continuum in Kenmore Square. He reports that he is happy to be among friends again.

Among those who have left our beloved Cambridge/Boston area is **Mark Enstrom**. After finishing his thesis, Mark took a job with Integrated Computer Solutions in Cambridge. He then got an offer from TTC-Telecommunications Techniques Corp. and left for Germantown, Pa. He says he is beginning to do a lot of business for TTC and is traveling quite a bit. . . . **Miriam Lawler** is working on a master's in environmental engineering out at the University of Illinois at Champaign-Urbana. If all has gone well, she should be finishing up right about now.

Rita Baranwal is currently in grad school at University of Michigan in materials science and engineering. She was awarded a National Physical Science Consortium fellowship for school and recently gave a talk at the American Ceramic Society's Annual Convention. . . . **Sue Raisty** was nice enough to write and tell us that she is working at National Semiconductor in Santa Clara, Calif., where she is developing software for network cards. Her roommate is Scott Fullam ('89) and she often gets visits from Helen Holder, '92, Lucy Tancredi, '94, Mark Uhrmacher, '94, and Stephanie Coleman, '92. She also tells us that **Gargi Sircar** is still in grad school at Columbia University. She will be getting a master's in electrical engineering and this summer she spent the month of June in London. Visiting someone?

Kathy Kostival received a master's in electrical engineering from Cornell this past May, and is staying on for a PhD in food science with minors in nutrition, hotel administration, and business/marketing. As Kathy said, "Move over Bell Labs. . .watch out Betty Crocker!" She also mentioned that **Jane Lee** is going on for further studies in architecture at Berkeley. She started this fall.

Jorge Alberto Calvo sent me a bunch of information on our fellow classmates. . . . **Steven Lustig** is getting a master's in mechanical engineering at Georgia Tech. He is enjoying the warmth and hospitality of the South. . . . **Eric Zimmerman** is at the University of Chicago working towards a PhD in physics. He spent several weeks in Geneva to perform experiments on the CERN accelerator and eat a horse. . . . **Gary Porter** is studying at "Hahvahd (*@&!) Law," and **Janet Lou** is pursuing her love of circuits at the University of Michigan. . . . Jorge has had a successful year. He was awarded the 1994 Raymond Wilder Award and passed his first two qualifier exams. This summer he did some research on knot theory and t.a.'d a linear algebra course.

That's all for now. Make sure to get in touch with the people named at the start of the letter. Also keep an eye out for Class of 1993 Directories. **Ivana Markovic** [Class VP] will be sending you more information. If you want to get on the MIT Class of 1993 mailing list, you can subscribe by sending mail to <listerv@mitvma.mit.edu>. In the e-mail write: SUBSCRIBE MIT1993. Make sure there is a space between "subscribe" and "MIT1993". Of course I can always be reached by writing—**Mari Madsen**, secretary, 12-16 Ellery St. #405, Cambridge, MA 02183

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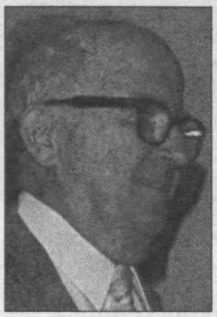
Please turn to page MIT 47 for an article about **Andrew Dickson**. . . . And then please send *your* news for this column to: **Walt Babiec**, president, c/o Aerospace Corp., Box 92957, Mail Stop M4/922, Los Angeles, CA 90009

CourseNews

I CIVIL AND ENVIRONMENTAL ENGINEERING

Glen E. Weisbrod, SM '78, MCP '78, has been named a principal at HBRS, Inc., in Boston. Previously, he was senior VP at Cambridge Systematics in Cambridge.



E. Russell Johnston

E. Russell Johnston, SM '47, ScD '49, professor emeritus of civil engineering at the University of Connecticut, has received the 1994 Archie Higdon Distinguished Educator Award from the American Society for Engineering Education. Johnston was civil engineering department head from 1972–77 and taught from 1963 to 1989. Johnston is best know for his texts *Vector Mechanics for Engineers* and *Mechanics of Materials*, available in eight languages and used by half of the engineering schools in the United States The ASEE praised one of his books as the "most successful engineering textbook ever published." Johnston has received numerous teaching awards including the Western Electric National Award in 1968 and the Excellence in Teaching Award from the Alumni Association at UConn in 1984. He also received the Benjamin Wright Award from the Connecticut Section of the ASCE for outstanding contributions in civil engineering in 1991.

William Weaver, SM '52, died on April 28, 1994. Weaver spent 25 years on the Stanford faculty, working as a professor and researcher in the field of structural analysis. He was one of the pioneers in applying advanced mathematical methods to analyze complex structures and dynamics—a technique that allows structural engineers to use computers to analyze how buildings respond to strong winds and earthquakes.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

II MECHANICAL ENGINEERING

John E. Sirmalis, '56, SM '58, executive director of the Naval Undersea Warfare Center (NUWC) Newport Division, has been presented with the prestigious Meritorious Executive Presidential Rank Award by the Secretary of the Navy. The award was presented at the Pentagon for Sirmalis's professional achievements for the Navy through September 1993. Sirmalis, a member of the federal government's Senior Executive Service, serves as the Navy's leading expert on undersea weapon systems for a number of international cooperative efforts. He regularly represents high-level U.S. Navy interests in coordinating allied nations, both in Europe and in the Far East. This is the second time that Sirmalis has received the award. He received it in 1984 when he was NUWC Newport Division's Director for Weapons Systems. For more than three decades, he has been involved in the full spectrum of underwater weapon and target design, development, and acquisition. This includes the development of significant advances in guidance and control systems, propulsion, hydrodynamics, structures, and quieting technologies related to torpedoes, targets, and missile system programs. Sirmalis began his civil service career in 1957 as a mechanical engineer at the Naval Ordnance Station, a forerunner of NUWC Newport Division. . . .

Omar Hasan

Omar Aquib Hasan, SM '91, PhD '94, has joined the GE R&D Center in Schenectady, N.Y., as a mechanical engineer. Hasan is a member of ASME and the Society of Rheology.

Ashok B. Boghani, SM '71, ME '73, ScD '74, has been named VP of Arthur D. Little, Inc. He continues as director of the transportation unit at the Cambridge-based company. . . **Adrian Bejan,** '72, SM '72, PhD '75, the J.A. Jones Professor of Mechanical Engineering at Duke University in Durham, N.C., won the 1994 ASME Heat Transfer Memorial Award (Science Category). This award was established in 1959 as a divisional honor. In 1974 it was elevated to a national society award recognizing outstanding contributions to the field of heat transfer through teaching, research, design, or publications. Bejan was cited for "significant and often unconventional contributions to heat transfer, notably in natural convection, thermodynamic aspects of heat transfer, convection in porous media, thermal tribology, solar energy conversion, cryogenics, and transition to turbulence; and for bringing modern research results and methods into heat transfer education."

Joseph Ting

Joseph K. Ting, SM '74, a mechanical engineer with the New York State Dormitory Authority in Delmar, N.Y., and an adjunct professor in HVAC&R at the Rensselaer Polytechnic Institute, in Troy, N.Y., was installed as a regional director by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). Founded in 1894, ASHRAE is an international organization of 50,000 members. As regional director, Ting serves on ASHRAE's board of directors as chairman of the society's Region I, which covers northern New Jersey, New York, and New England. As chairman, he oversees the activities of the chapters in this region and represents them in society activities. He will serve a three-year term from 1994–97. Ting is director of the MIT Club of the Capital District of New York.

Gordon J. Van Wylen, ScD '51, Ichiro Matsunaga, and Kan Sugahara are the authors of *Encounter at Sea and a Heroic Lifeboat Journey* (1994, Sabre Press). The book tells the WWII story of an encounter between the USS *Hardhead*, an American

DEGREE CODES

AE	Aeronautical Engineer
BE	Building Engineer
CE	Civil Engineer
CHE	Chemical Engineer
CSE	Computer Science Engineer
DPH	Doctor of Public Health
EAA	Aeronautical & Astronautical Engineer
EE	Electrical Engineer
EGD	Doctor of Engineering
ENE	Environmental Engineer
MAA	Master in Architecture Advanced Studies
MAE	Materials Engineer
MAR	Master in Architecture
MCP	Master in City Planning
ME	Mechanical Engineer
MET	Meteorologist
MIE	Mineral Engineer
MME	Marine Mechanical Engineer
MNG	Master in Engineering
MPH	Master in Public Health
MTE	Metallurgical Engineer
NA	Naval Architect
NE	Naval Engineer
NUE	Nuclear Engineer
OCE	Ocean Engineer
PhD	Doctor in Philosophy
ScD	Doctor of Science
SE	Sanitary Engineer
SM	Master of Science

SIGUS

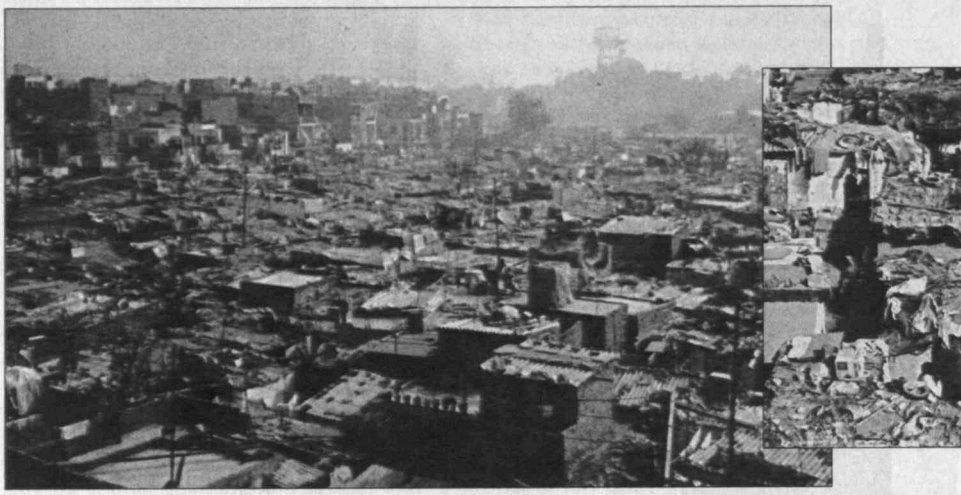
A Two-Way Learning Adventure

Suppose that your daughter announces that she will study architecture at MIT. You'd be enthusiastic—entertaining visions of serene seaside houses, state-of-the-art health centers, even a glitzy sky-scraper. Some months into her studies, she announces that she is about to spend two weeks in a workshop in India. She explains that her destination is Dakshinpuri, near New Delhi, arguably one of the most squalid and poorest of the developing world's many squatter slums.

It may not be what either of you originally had in mind, but it is a significant option for a number of MIT students.

As a student enrolled in architecture, planning, engineering, or the social sciences at MIT, she would have been able to apply for a place on an interdisciplinary team assembled annually by SIGUS—the Special Interest Group in Urban Settlements formed by the Departments of Architecture and Urban Studies and Planning. Members of the 1994 team went to India, where they joined students from Oxford Brookes University in Britain and Delhi's TVB School of Habitat Studies, the host. Their stated objectives were to explore "the new professionalism emerging for architects and planners" and to "learn the participatory method in promoting affordable and equitable housing."

Architecture and planning are in the midst of a significant and rapid transition, explains Reinhard Goethert, SIGUS director and a lecturer and principal research associate in architecture. The traditional arena, in which architects design houses, offices, and other facilities for owners and users, is shrinking; more and more U.S. buildings are constructed with little or no input from architects. Now, says Goethert, the action for many architects and planners depends on their ability to work in unconventional places and with new social units—neighborhood associations, owner cooperatives, and government and private agencies whose goal is to help the underprivileged and disenfranchised.



Dakshinpuri, the sprawling slum near New Delhi, was the IAP '94 destination for a student team from MIT's multidisplinary Special Interest Group in Urban Settlements (SIGUS). Their proposals for modest but feasible improvements inspired a detailed report in the* Economic Times *of New Delhi.

Since its founding in 1984, SIGUS has given MIT students a chance to experience how these trends play out in low-income communities around the globe—including Thailand, Nicaragua, Sri Lanka, Poland, Jamaica, Belarus (where people still live in houses contaminated by the Chernobyl nuclear accident in neighboring Ukraine), and, most recently, India. SIGUS teams are made up of MIT students, their Oxford Brookes counterparts, and students from an institution near the year's chosen site. The two-week workshops coincide with MIT's Independent Activities Period in January. Their next destination, during IAP '95, will be Lima, Peru.

The team visits the target community, learns its history, and talks to residents and government officials. Based on that information-gathering exercise, they propose and evaluate possible interventions to improve the local quality of life. The finale is a summary presentation at a meeting of all participants—including faculty from three institutions, officials, and community representatives. Upon returning to their home campuses, Goethert reports, many students continue work on problems identified through the workshop, sometimes going on to full-time summer research and even graduate theses.

In Dakshinpuri, for example, the students found the residents to be people who have run out of alternatives. But even in the face of overwhelming poverty, the children still want to learn, and their parents long for dignity even more than human comforts. Though government responses (if any) tend to be unimaginative and tradition-bound, Goethert believes that the reputations of MIT and Oxford helped to open doors and arouse official interest in—even acceptance of—some of the team's recommendations.

The educational name brands also attracted local media attention; the concluding presentation by the SIGUS students in the Dakshinpuri meeting hall last January was reported in the *Economic Times* of New Delhi. Among the measures recommended:

PHOTOS: REINHARD GOETHERT

collecting garbage and converting it to bio-gas; encouraging residents to form their own community organizations that could press for minimal urban services and help define and make use of public spaces; and the introduction of simple materials and methods that residents can produce and use to build or improve their homes.

Though they are less than revolutionary, recommendations such as these have led to noticeable improvements at the sites of previous SIGUS workshops, says Goethert.

Equally important to the MIT participants have been the insights—personal *and* professional—that they have gained. "The vast majority of the world's clients are its poor," wrote graduate student Kevin Sullivan (urban studies and planning) when he returned from Dakshinpuri last January. "They are ill-sheltered and ill-served by a profession that has chosen, by and large, to build for the rich. . . . We are challenged to rethink and redefine our roles in the context of an environment in which blueprints are drawn with sticks in the sand and change is the only constant."

Adnan Morshed, a graduate student in architecture, expressed similar sentiments. "Given the cities where millions lie on the pavements and in the filthy hovels of shanty towns," he wrote, "architectural education cannot any more be seen as merely a skill transmission. . . . What is enlightening about the experience of the urban ghetto of Dakshinpuri is a renewed search for self identity." He and his SIGUS colleagues had been transformed by their Dakshinpuri experiences "from egocentric image-builders to socio-political activists," suggested Morshed.

It is by no means a given, or even desirable, that every SIGUS participant will make a career in service to the world's poor. But Goethert is confident that all the participants will gain important new ways of thinking about themselves and the nature of their chosen profession.□ —*JOHN I. MATTILL*

submarine, and the HIJMS *Natori*, a Japanese light cruiser, and a heroic, 300-mile lifeboat journey by survivors of the *Natori*. Van Wylen and Matsunaga were senior officers on the two ships. Van Wylen served on the faculty and as dean of the College of Engineering at the University of Michigan, and as president of Hope College in Holland, Mich. His textbooks on thermodynamics have been used extensively in the United States and abroad in several translations.

The Association of Alumni and Alumnae has been notified of the following deaths: **Jens T. Jensen**, SM '83, of Perkinsville, Vt., on April 14, 1994; and Colonel **Grosvenor F. Powell**, SM '38, of Sacramento, Calif., in February 1986. No further details were provided.

CORRECTION: **Howard M, Schwartz**, SM '82, PhD '87 (II), was erroneously reported to be deceased in the August/September issue of *Tech Review*. Mr. Schwartz assures us that he is happy, healthy, and living in Ottawa, Ontario, Canada. He is an associate professor in the Department of Systems and Computer Engineering at Carleton University in Ottawa. His research interests include robot control, adaptive control, process control, neural networks, and vision systems. He is married with two children. We apologize for the error.—*Ed*

Alumni/ae may send information for Course News to <mitalum@mitvmc.mit.edu>.

III MATERIALS SCIENCE AND ENGINEERING

William H. Rhodes, ScD '65, sends word from Lexington, Mass.: "I was recently named manager of the Lighting Material Department in central research at Osram Sylvania, Inc., which resulted from the sale of the GTE electrical products group to Osram GMGH, a subsidiary of Siemens." . . . **Gerald S. Meiling**, SM '59, ScD '66, has been named senior VP at Corning, Inc. He continues as director of research at the Corning, N.Y.-based company. . . . **James E. Neeley III**, SM '92, has been named a predoctoral fellow in integrated manufacturing by the National Research Council following a competition sponsored by the DOE. The program, which began in 1993, has the threefold objective of creating a pool of PhDs trained in the integrated approach to manufacturing, promoting academic interest in the field, and attracting talented professionals to this area of engineering. Neeley, as one of 12 fellows picked out of a pool of 140 applicants, receives a stipend of $20,000 per year and an institutional cost-of-education allowance of up to $15,000 per year for three years of support.

Simon Moss, '56, SM '59, ScD '63, is the 1994 winner of the Esther Farfel Award, the most prestigious honor the University of Houston bestows upon its faculty. Ross joined UH in 1972 with the charge to build solid state physics, and in the past 22 years he has done that and more. A UH release states, "Moss' pioneering X-ray and neutron scattering studies of disordered and defective solids, contributions to the understanding of crystalline and noncrystalline materials, research on the structure of liquids and amorphous solids including glasses and colloids, and work with high-temperature superconductors, thin films, and Carbon 60

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crystals is recognized nationally and internationally." Moss won a Guggenheim fellowship in 1968 and was elected a Fellow of the APS in 1975. In 1990, he received the UH Excellence in Research Award. Within the past year, he has won the Max Planck Research Award from the APS. He serves on many NAS and NSF committees and is a division associate editor for the *Physical Review Letters*, the most prestigious research journal in physics.

Jill P. Kern, '77, has been named treasurer of the American Society for Quality Control (ASQC). Kern is a principal engineer with Digital Equipment Corp.'s worldwide semiconductor organization in Hudson, Mass. She has more than 15 years of experience in quality assurance and engineering quality management at Babcock and Wilcox, Burroughs, and Digital. She is a senior member of ASQC and has held various posts including serving three terms as the society's VP for publication services. Kern has also served as a consultant to the Massachusetts state government's Commonwealth Quality Improvement Council, supporting a team from the governor's office in total quality management implementation. She is also a senior member of the Society for Women Engineers.

The Association of Alumni and Alumnae has been notified of the following deaths: **Antonio W. Diokno**, SM '39, of Makati, The Philippines, on July 15, 1993; and **Edgar J. Moor**, '44, of Cambridge, on July 1, 1994. No further information was provided.

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IV ARCHITECTURE

Frederick L. Merrill, Jr., SM '80, MCP '80, has rejoined Sasaki Associates, Inc., in Watertown, Mass., as a senior associate and planner. Merrill has 14 years' experience in real estate development, land planning, and asset management. After working at Sasaki Associates from 1983 to 1987, he held senior positions at two Boston real estate firms. His focus at Sasaki will be on assignments with a significant real estate component, including land planning and development, public/private partnerships, urban investment programs, institutional planning, and resorts. . . . **Bill C. Booziotis**, MAR '60, has been named to the MIT Council for the Arts. Booziotis, of Booziotis and Co. in Dallas, Texas, serves on the MIT Grants Committee and was instrumental in planning the Gala Dallas Weekend held April 22–24, 1994.

The Association of Alumni and Alumnae has been notified of the following deaths: **Charles H. Neuhardt**, MAR '47, of Midland, Texas, in 1994; and **John Clymer**, MAR '49, of Natick, Mass., in 1993. No further details were provided.

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V CHEMISTRY

Ze'ev Shaked, PhD '81, has been named senior VP for pharmaceutical development at Immulogic Pharmaceutical Corp. in Waltham, Mass. . . . **Atsushi Nagahisa,** PhD '84, has received a 1994 Central Research Achievement Award at Pfizer. Of the 25 awardees, Nagahisa is one of three based at the company's Nagoya, Japan research facility. He was cited for "effective leadership and exceptional initiative and insight in identifying and implementing new discovery approaches in the areas of inflammation and pain." . . . Clemson University chemist **John D. Beckerle,** PhD '88, has been selected to receive a NSF Young Investigator Award for 1994. An assistant professor of chemistry, Beckerle is one of 20 people nationally who will receive the award in chemistry this year. Each investigator may receive up to $100,000 per year for five years under the program. The NSF provides a $25,000 annual base grant and will add up to $37,500 more, provided the recipient obtains dollar-for-dollar matching funds from industrial and non-profit sources. With research interests in the fundamental chemistry of metal and semi-conductor surfaces, Beckerle joined the Clemson faculty in 1991 after working for three years at the National Institute of Standards and Technology in Gaithersburg, Md.

John Beckerle

Diane Joseph-McCarthy, PhD '92, will be working on a project entited "The Design of New Structure-Based Drugs for Poliovirus and Related Viruses through the Use of Computational Methods" at the Bunting Institute of Radcliffe College from September 1994 to August 1995. In explaining her project, Joseph-McCarthy writes, "Virtually all lead compounds for new drugs have been found through large-scale, random screening of known chemicals—a very expensive and time-consuming process. The objective of the proposed research is to design new drugs for poliovirus and related viruses, through the use and development of novel computational techniques. The scheme for computational drug design presented here involves first calculating where in the drug binding site specific functional (chemical) groups have potential energy minimal, then clustering and connecting the resulting functional group minimal to design new ligands or drugs for the binding pocket, and finally predicting how tightly the ligands will bind. In preliminary work, functional group maps of the poliovirus binding site have been made and two candidate drugs designed."

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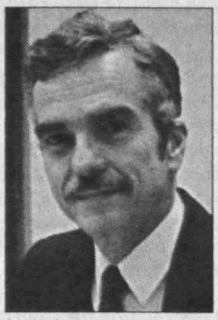
VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Steven V. Sperry, SM '78, writes: "I'm weathering the defense downturn at TRW in Redondo Beach, Calif. I frequently see fellow alumnus **Dan Lane,** '85, SM '86, and occasionally cross paths with Russ Bock, '69 (XVI), **Dave Bernstein,** '74, SM '75, and Andy Cohen, '81 (XVI), SM '82 (II). Went to Japan in 1991 with my wife, Noriko, and our two children, Andrew and Kaoru." . . . **Arthur L. Fox,** SM '72, reports: "I have developed a new form of royalty base financing for new and existing businesses. This methodology is employed by a new venture capital fund called Royalty Capital Fund, of which I am a principal and co-founder." . . . **Alan E. Baratz,** SM '79, PhD '81, has been named CEO at Delphi Internet Services Corp. in Cambridge. He used to be director of the High Performance Computing and Communication Unit at IBM Corp. in New York, N.Y. . . . **Babar Khan,** '75, SM '77, PhD '84, a staff scientist at Philips Laboratories' Briarcliff facility, has received an annual Technical Achievement Award by his employer. The award honors researchers whose work on highly advanced concepts displays exceptional initiative and competency. Khan was recognized for inventing a new ultra-miniature, low-cost lighting technology called Microlamp. Khan was awarded a U.S. patent for his innovation and received a $5,000 cash prize from Philips. The MicroLamp, winner of the Lab's

Basic Research award, is a new lighting element that is based on semiconductor manufacturing processes. Khan joined Philips Laboratories in 1984 as a member of the materials engineering research team.



Cyrus Harbourt

Cyrus O. Harbourt, SM '55, was elected VP of the Missouri Society of Professional Engineers (MSPE), a 2,500-member statewide association located in Jefferson City. Harbourt is a professor of electrical and computer engineering at the University of Missouri College of Engineering. A member of the UMC faculty since 1976, he has served as Electrical Engineering Department chair, director of Engineering Extension, and interim dean for the College of Engineering. He is the current president of UMC's Phi Kappa Phi honor society, and a member of Tau Beta Pi, Eta Kappa Nu, and the American Society of Engineering Education. Founded in 1937, MSPE is the only organization in Missouri to represent all disciplines and practice areas of the engineering profession. Its members advocate strong registration laws, professionalism, and ethical practice to protect the public health, safety, and welfare.

Joseph H. McCusker, SM '49, of Princeton, N.J., died on June 1, 1994. An Army veteran of WWII, McCusker served in a special engineering detachment that worked on the Manhattan Project, code name for the work that led to the building of the first atomic bomb. From 1949 to 1951 he was an instructor in the Electrical Engineering Department at Penn State University. From 1952 to 1956 he worked at Lincoln Laboratories, where he helped develop the first working random-access high-speed ferrite memory. In 1956 McCusker joined RCA and helped set up the Materials Laboratory in Needham, Mass., where he was manager of advanced development in synthesized ferrites. From 1960 until he retired in 1987, he was a research electrical engineer at RCA David Sarnoff Laboratories in Penns Neck. He worked on fabrication of diode matrices by electron-beam bombardment, packaging of MOS transistors, development of thin film transistors, solid-state adaptive devices, microsonic surface wave filters for signal processing, and porcelainized-steel substrates for consumer applications. Beginning in the 1970s he worked on increasing the reliability of high-voltage transformers for television applications. McCusker received many patents and had many articles published while at RCA. He was a member of Tau Beta Pi and Sigma Xi.

Peter R. Metz, SM '58, died on June 10, 1994. An obituary that ran in the *Seattle Times* mentions that Metz was 59 when he died unexpectedly. His varied career in the electronics field began when he was an assistant professor in electronics engineering at the University of Washington. He then became professor of electronics engineering in Brazil and while there, developed and launched a bio-engineering program at the Federal University of Paraiba. He began his employment at Boeing in 1977 as an engineer in the avionics field, progressing through numerous positions including avionic technical consultant and, eventually, avionics lead engineer. While at Boeing, he received many awards and honors including being selected as a Technical Fellow in January 1994.

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VI-A INTERNSHIP PROGRAM

I seem, lately, to be starting these articles telling about our weather extremes; first last winter and, now, this summer. 3-H weather, prolonged hazy, hot, and humid, has been Boston's June/July weather. Fifteen consecutive days of 90° plus in July; the highest dew point ever recorded in Boston (78°); very little rain; per the weather bureau: "the worst summer since 1862" (no, the 18's not a typo). Air-conditioners and fans are sold out. An air-conditioned office has been a treat.

As of July 1, 1994, **Markus Zahn,** '67, SM '68, EE '69, ScD '70, officially took over as director of the VI-A Internship Program, following an overlap in the spring term with **J. Francis Reintjes,** who was acting director through June 30, 1994. Zahn, hence, attended many of the spring term VI-A meetings for new and continuing students held by the VI-A faculty advisors. Additionally, he has accompanied many faculty advisors on their annual visits to local companies with hopes of visiting all our companies over the next year; meeting students at their work assignments, and getting acquainted with their company supervisors and the company's management.

Professor Zahn reports that the VI-A Program is very healthy, with students reporting stimulating work assignments. Also, he says he has been pleasantly surprised at having received many phone calls from new companies expressing interest in joining the program.

Correspondence with **Cecil H. Green,** '23, SM '24, says he's "glad to report that the annual TI VI-A luncheon session was both successful and enjoyable, held, as usual, at the Dallas Petroleum Club on July 19. Attendence totaled 38 including TI's 12 VI-A students, supervisors, and company officials.

In the honors & awards category, I'm proud to announce that a VI-A alumna has been chosen by the Eta Kappa Nu Association (EECS honor society) to receive this year's C. Holmes MacDonald Oustanding Teacher Award in a national competition. She is **Denice D. Denton,** '82, SM '82, EE '83, PhD '87, professor of electrical and computer engineering at the University of Wisconsin at Madison. Denice recently stopped by for a short visit while on campus for a committee meeting with MIT President Charles Vest.

Alums having contact with the VI-A Office since last writing has included **John F. Cooper,** '76, SM '76, who has changed employment to Plantronics in Santa Cruz, Calif. . . . **Michael R. Crystal,** '87, SM '87, of BB&N in Cambridge, who was on campus taking the Speech Spectrogram Reading course, stopped by for lunch one day and told me that his folks (his dad is **Thomas H. Crystal,** '60, SM '60, ScD '66) have moved to New Jersey and were in Naples, Italy, on vacation at the time. . . . **Michael A. Isnardi,** '83, SM '83, PhD '86, of Sarnoff Labs,. sent e-mail testing to see if my e-mail was working (it obviously was). . . . **Karl M.J. Lofgren,** '77, SM '77, chief scientist for Western Digital in Irvine, Calif., stopped by for a July visit and told me that his wife, **Christine R. Lofgren,** ScD '77, SM '77, is with the University of California at Irvine. . . . **Edward J. Oullette,** '94, SM '94, and I had lunch. He told me he has completed the MIT master's work and is now preparing for his oral qualifiers planned for September. . . . E-mail from Marion Reine, SM '65, PhD '70 (VIII), of Loral Infrared & Imaging Systems, Inc., states that their former student, **Pierre R. Yanney,** '88, SM '88, went on to law school at Rutgers, and is now with the New York firm of Darby & Darby.

As you can see, e-mail is bringing a number of responses, so feel free to use it for updating VI-A news!—John A. Tucker, director (emeritus), VI-A Program, MIT, Room 38-473, Cambridge, MA 02139-4307 <jat@fenchurch.mit.edu>.

VII BIOLOGY

Mark B. Fefferman, '77, died on June 25, 1994, his 47th birthday, as a result of injuries suffered when he was struck by an automobile while changing a flat tire. According to an obituary that ran in the *Philadelphia Inquirer*, Fefferman had been medical director of the geriatric evaluation unit at the VA Medical Center in Coatesville for the last four years. He was recognized for his special interest in elderly, poor veterans, and patients suffering from Alzheimer's disease. Before becoming a staff physician at Coatsville in 1990, he worked there part-time for three years while maintaining a family practice in Lancaster, Pa. He also worked at Planned Parenthood in Lancaster. In the 1980s, Fefferman had done research on AIDS, with the results published extensively.

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VIII PHYSICS

William T. Walter, PhD '62, sends word from Huntington, N.Y.: "AIL Systems has been awarded two of Bill Clinton's Technology Reinvestment Programs. I am the principal investigator for the remote molecular monitor, which will use neural networks and pattern recognition techniques to improve signal processing and detection sensitivity to identify molecular species in the atmosphere for environmental and defense applications." . . . The fourth annual Prix du Livres d'Astronomie has been awarded to **Charles A. Whitney,** '51, senior scientist at the Smithsonian Astrophysical Observatory and professor emeritus of astronomy at Harvard University, and Kenneth R. Lang, professor of astronomy at Tufts University for their book *Vagabonds de l'Espace*, a comprehensive description of Space Age exploration and discovery in the solar system. The prize, which brings with it an award of 15,000 French francs, was given for the Springer-Verlag French edition of the book originally published in 1991 by Cambridge University Press as *Wanderers in Space*.

Elsa Garmire

Elsa Garmire, PhD '65, the William Hogue Professor of Electrical Engineering/Electrophysics, professor of physics, and director of the Center for Laser Studies at the University of Southern California, is the recipient of the 1994 Society of Women Engineers Achievement Award. Garmire is cited for "breakthrough contributions in optical science and engineering, particularly in non-linear optics. She has made outstanding contributions to the improvement of optical devices and processes for application to the field of information technology," an SWE news release states. "A true pioneer and major internationally recognized contributor in three important fields within optics—nonlinear optics, integrated optics, and optical logic elements—her contributions include: the discovery and explanation of key features of stimulated light scattering and self-focusing; the first demonstration of many of the key components of integrated optics in semiconductors (now know as optoelectronics), as well as authorship of the field-defining book chapter on the subject; introduction, demonstation and analysis of the generic class of hybrid electrical-optical bistable devices, a technology that has proved pivotal in digital optical computing. Garmire has made seminal and sustained contribtutions in semiconductor lasers, infrared transmissive fibers, and ultra-fast optical technology." She is a member of the NAE, the SWE, and a fellow of both the Optical Society of America and the IEEE.

David G. Biron, PhD '81, of Chelmsford, Mass., died on June 24, 1994. Biron worked as a physicist at Lincoln Laboratory in Lexington, Mass. . . . The Association of Alumni and Alumnae has been notified that **William B. Pohlman, Jr.**, PhD '51, of Northridge, Calif., died in January 1993. No further information was provided.

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X CHEMICAL ENGINEERING

Cathryn Ann Shaw is one of 100 minority scholars to be awarded a fellowship by the 1994 Ford Foundation fellowships programs. The programs, administered by the National Research Council, seek to increase the presence of underrepresented minority groups on the nation's college and university faculties. As a dissertation fellow, Shaw receives a stipend for a 9- or 12-month tenure. . . . **Hugh R. James**, CHE '74, has been named senior VP of Tenneco Gas International, Inc., in Houston. His new company is a subsidiary of Tenneco, Inc. Previously, James was VP at Brown and Root, Inc., a Dallas-based subsidiary of Halliburton Co. James will also be general manager of Tennaco, Inc.'s, international and power generation group's business activities in Southeast Asia and Europe. . . . **Alan E. Surosky**, '41, is the author of *The Expert Witness Guide for Scientists and Engineers* (1993, Krieger Publishing Co.). According to the book's jacket it "provides the technical specialist with all of the information, both technical and legal, necessary to build a highly paid, recession-proof practice in the exciting field of forensic engineering." For over 35 years, Surosky was active in test engineering, serving as chief engineer of the United States Testing Co., as president of General Testing Laboratories, and as a consulting engineer in private practice. He has been an advisor to the U.S. Army Engineering Laboratories and to the U.S. Department of Transportation for many years. He has been in many hundreds of investigations, failure analyses, depositions, and court appearances.

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X-A PRACTICE SCHOOL

Though work at the station is still in process as this is written, the response is clear: all those involved in the summer Practice School station at the Army Natick R D & E Center in Natick, Mass.—students, faculty, and the host laboratories—are enthusiastic. Readers will remember that we reported in the last issue a last-minute contract for a station at Natick to help reduce SCEP's lengthening waiting list.

From Atherton, Calif., **Nelson Bogart, Jr.**, SM '39, writes that he's been retired from Chevron for 16 years. "Time just flies by!" he says. "Looking forward to a cruise to Alaska in late August to return to an area we visited many times on business."

Though he's not a SCEP alumnus, **David Anderson**, '86, fortunately chanced to see the recollections of the Bangor Station from **Arthur J. Power**, '42, in this space for July. In response he writes from Auburn, Maine, about the Brewer mill in which so many SCEP graduates worked between 1917 and 1957. Anderson grew up in Brewer and remembers when the Eastern Corp. closed the mill in 1969. Here's a condensation of his letter shared with us by Power: "A group of investors persuaded Brewer to issue municipal bonds to restart the facility in the 1970s, when it had three Fourdrinier machines that made fine printing and writing papers. Among other improvements to revitalize the mill, its new owners installed two silicone coaters to make release liner for pressure-sensitive labels, and paper made at other mills was soon being brought to Brewer to be coated.

"Around 1980 I began working summers at the plant doing outdoor yard work. After I graduated from high school and had been accepted at MIT I could no longer work on the yard crew due to union regulations. So the company gave me a job in the research laboratory, where I learned about the Practice School while using the MIT fold endurance tester. I also worked at Eastern for two summers while enrolled at MIT, mostly on development for the silicone product line but also occasionally on the paper machines.

"After my junior year at MIT, having visions of grander things to come, I decided it was time to broaden my horizons. I wanted a job outside Maine, and I felt the paper industry was nontechnical—wouldn't know research if it fell on them. So I went to work for Professor **Jefferson Tester**, PhD '71, then

SCEP director at MIT, who told me more about the Practice School and the Bangor Station.

"A year later, approaching graduation from MIT, I interviewed with several petroleum, solar energy, and environmental firms and finally with S.D. Warren Co., which was hiring for its research laboratory in Westbrook, Maine. I was pleasantly surprised to find that I had been wrong about the technical depth of the paper industry and accepted Warren's offer. Six years later I moved to Otis Specialty Papers in Jay, Maine, which makes base paper for silicone release liners. And who is our third largest customer? Eastern Fine Papers, of course. No wonder I sometimes feel the circle has been closed.

"Your tale of the operator who cut off your necktie reminded me of a co-worker at S.D. Warren who used to boast about doing the same thing to senior management when they got too close to his coater. We may have more sophisticated flow measurement systems now, but you can still find seasoned operators who can tell the quality of the pulp by its 'feel' or 'smell'."

Carol Phillips in the SCEP office reports a call from Brazil: **Steven Odio**, SM '90, finished an MBA at Harvard last June and now is working with his father in Gumaco Industry and Commerce Co., in the heart of Brazil's orange orchards about three hours from São Paulo; the company sells equipment for growing and processing (what else?) oranges. . . . From American Cyanamid in Bound Brook, N.J., where she works in process development, **Hongbin Ni**, SM '93, reported in mid-summer that she and her husband, Bing Ni, expected a baby in October; Bing is still in Cambridge—a graduate student in oceanography and at best only a part-part-time father.

The Alumni/ae Association has just been informed that **Campbell C. Hyatt, Jr.**, who attended SCEP with the class of 1932, died at his home in Kingsport, Tenn., late in 1989. . . . **C. Wheeler Coberly**, SM '36, died in Pasadena, Calif., on May 17, 1993; before retirement he rose to senior executive responsibilities with Petrolane Gas Service, Inc., Long Beach. . . . **Leonard E. Carlsmith,**, SM '23, retired in the mid-1960s to Summit, N.J., after a 30-year career in technology licensing with various units of Standard Oil Co. in Baton Rouge, Elizabeth, N.J., and New York City. He died in Oak Ridge, Tenn., last April 11.—John Mattill, *Technology Review*, Room W59-200, MIT, Cambridge, MA 02139; or send information to Carol Phillips, SCEP, Room 66-307, MIT <carol@pracschool.mit.edu>.

XI URBAN STUDIES AND PLANNING

Edward H. Kaplan, SM '79, MCP '79, SM '82 (XVIII), PhD '84, sends e-mail: "My wife, Karen, and I announce the arrival of our daughter Allison Viktorija Kaplan. Allison was born in Kovno, Lithuania. After a wild trip through Vilna, Warsaw, Rome, and Jerusalem, she has now taken over our house in Hamden, Conn. Also, my new book *Modeling the AIDS Epidemic: Planning, Policy, and Prediction*, co-edited with Margaret Brandeau of Stanford, was just published by Raven Press. The book contains state-of-the-art papers addressing policy and epidemiological and behavioral aspects of AIDS from the perspective of mathematical modeling. I have just returned from my sabbatical in Israel and am preparing for yet another one of those Yale years." . . . **Frederick L. Merrill, Jr.**, MCP '80, SM '80 (IV), has rejoined Sasaki Associates, Inc., in Watertown, Mass., as a senior associate and planner. Merrill has 14 years' experience in real estate development, land planning, and asset management. After working at Sasaki Associates from 1983 to 1987, he held senior positions at two Boston real estate firms. His focus at Sasaki will be on assignments with a significant real estate component, including land planning and development, public/private partnerships, urban investment programs, institutional planning, and resorts.

Terri Montague

Terri Y. Montague, SM '92, MCP '92, has been promoted to assistant VP at the Boston Financial Group in Boston. She now heads the customer service team, which is responsible for customer service and operations for the public and private retail investments. Montague was formerly a real estate investment analyst in the company's financial asset management division. .

Glen E. Weisbrod, SM '78 (I), MCP '78, has been named a principal at HBRS, Inc., in Boston. Previously, he was senior VP at Cambridge Systematics in Cambridge. . . . . **Paul Osterman**, PhD '76, and Thomas A. Kochan, both Course XV professors, have written *The Mutual Gains Enterprise: Forging a Winning Partnership Among Labor, Management, and Government* (Harvard Business School Press, 1994). In the book, the authors make "an urgent and compelling call for workplace reform, showing how American business can indeed attain world-class, *sustainable* competitive advantage—in addition to securing more rewarding employment for workers," according to the jacket. Case studies of GM's Saturn plant and Motorola, among others, confirm the existence of companies that reformed and successfully implemented new work systems. Kochran is the George M. Bunker Professor of Management and Leaders for Manufacturing Professor as well as a member of the Labor Department's Commission on the Future of Worker Management Relations. Osterman is professor of human resources and management at the Sloan School.

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XII EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

Paul T. Walton, PhD '42, has written his autobiography: *From Prospect to Prosperity: Wildcatting in Arabia and the Rockies* (Utah State University, 1994). Walton played a role in an important chapter of world oil history as the discoverer of and negotiator for the Wafra oil

Roger Burns

1937–1994

Roger Burns, professor of mineralogy and geochemistry in Course XII, died on January 7, 1994. He was well-known for his role in developing the field of mineral spectroscopy and as the author of *Mineralogical Applications of Crystal Field Theory*. The book has been translated into Japanese, Chinese, and Russian, and a revised second edition was published in 1993. Burns was a pioneer in studying minerals using absorption spectra, a technique whereby the selective absorption of light with different wavelengths reveals the location and atomic coordination (the arrangement of atoms around another atom in a crystal structure) of transition metals—such as nickel and copper—in minerals.

From 1966 to 1970, while he was a faculty member/researcher at Oxford University, Burns and colleagues developed a new research approach for understanding the structure of minerals by applying a variety of spectroscopic techniques. They made important advances, not only in the specialized field of crystal chemistry, but also in understanding the causes of color in minerals and gems, an aspect of his research that has significance beyond the realm of science.

Burns joined the MIT faculty in 1970 as an associate professor and within two years was promoted to full professor. In the 1970s, he and his wife, Virginia, were instrumental in characterizing and understanding the ubiquitious formation of manganese-rich materials on the seafloor. He was motivated in part by a desire to pursue research that would have positive societal impact. In recent years, he continued his interest in applied research by evaluating the reactivity of zeolites in proposed repositories for high-level nuclear waste. Throughout his career he was an active consultant, with clients ranging from the Battery Products Division of Union Carbide to a manufacturer of synthetic gems to the Nevada nuclear-waste isolation program.

Also in the 1970s, Burns collaborated with experimental mineralogists to obtain spectroscopic data while minerals were subjected to very high pressures and temperatures in a "diamond cell," a press whose "jaws" are millimeter-size diamonds. Because the diamonds are transparent, measurements can be made while the mineral is at high pressure and temperature. With this device, Burns and his students were among the first to observe atomic coordination changes in silicate minerals at high pressure.

Burns was also interested in oxidation states of planetary interiors and how they might be recorded by transition metals in magmas—molten rock in planetary cores. He applied spectroscopic techniques to determine the redox state of the lunar interior as recorded in small glass spheres erupted in volcanic fire foundations on the moon's surface. Burns was instrumental in melding together the previously diverse fields of planetary science and mineralogy. He recognized that spectral profiles of sunlight reflected from planetary surfaces combined with measured spectra of minerals in the laboratory could be used to identify the minerals on planetary surfaces. Together with MIT planetary scientists, Burns developed the techniques for using remote-sensed reflectance spectra to identify transition metal-bearing minerals on the surfaces of distant planets, and the recently published second edition of his book has a chapter devoted to the topic of determining the compositions and mineralogy of planetary surfaces by remote sensing. Beginning in the early 1980's he made major contributions to understanding the composition and mineralogy of the Martian surface.

An enthusiastic teacher of graduate and undergraduate students, Burns devoted considerable effort each semester to teaching "Chemistry and Physics of Minerals and Rocks" and "Geochemistry of the Transition Elements." In 1975, he was presented the Mineralogical Society of America Award for his leadership in mineralogy, and he was a life fellow of the the Mineralogical Society of America. □—*Frederick A. Frey and Timothy L. Grove* (Course XII professors)

In the photo above, Roger Burns (right) and then-graduate student Chien-Min Sung, PhD '76, examine manganese nodules brought up from the ocean floor. They were studying the atomic structure and microchemistry in order to learn how the copper, nickel, and cobalt could get trapped in them. The nodules grew around foreign objects such as a piece of pumice, a shark's tooth, altered basalt, or whale bone.

PHOTO: MIT MUSEUM/CALVIN CAMPBELL, CIRCA 1975

fields in the Middle East during the 1940s, making J. Paul Getty the richest man in the world. Walton was also involved in the Intermountain West, discovering the Clear Creek gas field that fueled Utah's growth in the '50s. The book jacket claims he has led a life that would "leave Indiana Jones panting in the dust."

Navy Captain **Thomas J. Kelley**, SM '69, NE '69 (XIII), recently retired after 30 years of service. Kelley most recently served as the commanding officer of the Naval Sea Support Center Pacific in San Diego. During his tour as commanding officer, the center often earned recognition for its exceptional technical and logistics support to the Pacific Fleet. For excellence in retaining high-quality personnel, the command earned the Naval Sea Systems Command "Golden Anchor Award" for two consecutive years. During Kelley's naval career, he served aboard a variety of ships, including cruisers, destroyers, and aircraft carriers, as well as at shore duty assignments, around the world. Among his personal awards and decorations are the Legion of Merit, the Meritorious Service Medal, the Navy Commendation Medal, and varous campaign, unit, and service ribbons.

The Association of Alumni and Alumnae has been notified that Captain **Ronald R. Marston**, '56, of Kennewick, Wa., died in 1993. No further information was provided.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

XIII OCEAN ENGINEERING

Navy Captain **Thomas J. Kelley**, SM '69 (XII), NE '69, recently retired after 30 years of service. Kelley most recently served as the commanding officer of the Naval Sea Support Center Pacific in San Diego. During his tour as commanding officer, the center often earned recognition for its exceptional technical and logistics support to the Pacific Fleet. For excellence in retaining high-quality personnel, the command earned the Naval Sea Systems Command "Golden Anchor Award" for two consecutive years. During Kelley's naval career, he served aboard a variety of ships, including cruisers, destroyers, and aircraft carriers, as well as at shore duty assignments, around the world. Among his personal awards and decorations are the Legion of Merit, the Meritorious Service Medal, the Navy Commendation Medal, and varous campaign, unit, and service ribbons.

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XIV ECONOMICS

Alan S. Blinder, PhD '71, has been named vice chairman of the Federal Reserve Board in Washington, D.C. In assuming this new position, he steps down as a member of the Council of Economic Advisors. He continues as a professor of economics at Princeton University. **Robert M. Solow** has been elected to the board of directors at Saint-Gobain Corp. in Valley Forge, Pa. Institute Professor Solow, who began his career at MIT in 1950, serves

Robert Solow

as a trustee of the Alfred P. Sloan Foundation and the Woods Hole Oceanographic Institute. Saint-Gobain is the holding company for the U.S. and Canadian-based businesses of Compagnie de Saint-Gobain (Paris, France), including Certain-Teed Corp. (Valley Forge, Pa.), Norton Co. (Worcester, Mass.) and the subsidiaries of each. SGC employs more than 24,000 people and operates more than 120 plants in 27 countries. . . . **Rebecca Blank**, PhD '83, has edited *Social Protection vs. Economic Flexibility: Is There a Tradeoff?* (University of Chicago Press, 1994). The book explores how programs such as social security, income transfers, and child care in Western Europe, the United States, and Japan have affected labor market flexibility.

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XV MANAGEMENT

Lee R. Morris, SM '54, writes from Rydal, Pa.: "I'm enjoying retirement—doing some consulting for non-profits." . . . From Aurora, Colo., **Stephen G. Pearse**, SM '82, reports: "I have left Sprint to become senior VP for engineering, technology, and operations at Time Warner. We are creating a nationwide local telephone/full service cable network. The convergence of technologies is exciting!" . . . **Khalid Saeed**, SM '81, is a professor at the Asian Institute of Technology in Bangkok, Thailand. He writes: "I have published a new book, *Development Planning and Policy Design, A System Dynamics Approach* (London: Ashgate, 1994)." . . . **Paul N. Schregel**, SM '64, resigned as senior VP at Scott Paper Co. in Philadelphia. . . . **Robert C. Salipante**, SM '81, has been named senior VP for marketing and technology at the NWNL Co. He was senior VP and CFO at the Minneapolis-based company. . . . **Sandra L. Helton**, SM '77, has been promoted from VP and treasurer to senior VP and treasurer at Corning, Inc., in Corning, N.Y. . . . **Steven R. Kanner**, SM '74, internal medicine physician and chairman of RTJ Corp. in Waltham, Mass., announces $1.1 million in private financing to expand the marketing and distribution of Medical Master—The Doctor's Workstation, RTJ's state-of-the-art medical software. Introduced in 1992, Medical Master is currently being used in teaching hospitals, clinics, and doctors' offices. It "keeps complete patient records, produces clinical documents such as prescriptions and lab requisitions, schedules patient appointments, generates and reconciles insurance bills, and provides comprehensive reports on the medicall and financial status of the practice," according to an RTJ press release. . . . **Lotte Bailyn**, the T. Wilson (1953) Professor of Management in the Sloan School, has published *Breaking the Mold: Women, Men, and Time in the New Corporate World* (The Free Press, 1993). Bailyn "illus-

CourseNews

trates common problems employees encounter in coordinating work and private life, and details how corporations typically handle these problems. She explains why these current company efforts usually fail and how the innovative programs of some companies can serve as a model for other corporations," according to the book's jacket. . . . **Paul Osterman**, PhD '76 (XI), and **Thomas A. Kochan**, both Course XV professors, have written *The Mutual Gains Enterprise: Forging a Winning Partnership Among Labor, Management, and Government* (Harvard Business School Press, 1994). In the book, the authors make "an urgent and compelling call for workplace reform, showing how American business can indeed attain world-class, *sustainable* competitive advantage—in addition to securing more rewarding employment for workers," according to the jacket. Case studies of GM's Saturn plant and Motorola, among others, confirm the existence of companies that reformed and successfully implemented new work systems. Kochan is the George M. Bunker Professor of Management and Leaders for Manufacturing Professor as well as a member of the Labor Department's Commission on the Future of Worker Management Relations. Osterman is professor of human resources and management at the Sloan School.

The Association of Alumni and Alumnae has been notified of the following deaths: **Theordore E. Hlavac, Jr.**, SM '66, of Oakmont, Pa., in 1993, and **David G. Lyons**, '68, of Elsah, Ill., on February 12, 1994. No further information was provided.

SLOAN FELLOWS

Thomas A. Helmrath, SM '77, reports: "I was named president and CEO of Physicians of The Ohio State University, Inc., last April. The P/OSU is an integration of the 15 academic practice plans into a single corporation that is a multi-specialty group practice of 450 physicans. This corporation is not under the control of the university, but it is an integral part of the joint efforts to secure patient care contracts for both the University Hospital and ourselves." . . . **John F. Fiedler**, SM '79, has been named president and COO at Borg-Warner Automotive in Chicago, Ill. He was executive VP at Goodyear Tire Co. previously. . . . **Louis C. Golm**, SM '80, has been named president and CEO of AT&T Japan, a newly created position in which he will lead AT&T's business units in developing and implementing company-wide strategies in Japan. . . **Bruce S. Gordon**, SM '88, has been named group president for consumer and small business at Bell Atlantic Corp. He served as president of consumer services at the Arlington, Va.-based company.

Louis Golm

SENIOR EXECUTIVES

Gilberto Pinzon, '91, has been named VP of Nalco Chemical Co. and president of Nalco Latin America in Naperville, Ill. Previously, he was division VP of Nalco Latin America and general manager of Nalco de Venezuela. . . . **Edward J. Mooney**, '79, has been named chairman of Nalco Chemical Corp. He continues as CEO and president of the company.

John Griffin

John M. Griffin, '84, director of the the Development Planning System Program Office in Aeronatical Systems Center at Wright-Patterson AFB in Ohio, has been honored with the Presidential Rank Award for his pioneering work in low observable, or stealth, technology. Griffin accepted the award from **Sheila Widnall**, '60, secretary of the Air Force, during a formal presentation at the Pentagon in Washington, D.C. Griffin is credited with many significant accomplishments in integrated engineering and technical management, and has developed several new engineering products for aeronautical systems. He was cited for "his superb vision and leadership, which have been instrumental in designing test proof-of-concept programs to investigate reduction of aircraft radar signatures and all other aircraft emissions, making multi-billion-dollar weapons systems less visible to enemy radar." Griffin was director of engineering for the B-2 Advanced Technology Bomber from the program's inception in 1980 to its first flight in 1989. He was solely responsible for engineering development of the B-2—ensuring integration of all hardware and software into the system. In October 1989, Griffin was named chief systems engineer; he and his 1,000-member team were early practitioners of integrated product development as a way to bring together individuals from multi-disciplined specialties to work on one product. Griffin was an advisor to senior Air Force officials who were merging Air Force Systems Command and Air Force Logistics Command into the Air Force Materiel Command.

The Association of Alumni and Alumnae has been notified that **William G. Lewis**, '64, of Kennett Square, Pa., died on May 15, 1994. No further information was provided.

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MANAGEMENT OF TECHNOLOGY

Keying Ren, SM '89, was mentioned in the July 18, 1994, issue of *Business Week*. In an article entitled "The Great Chinese Talent Hunt," Keying was cited as one of the "hot properties" as multinational corporations search for executives in China. She is now in Bear Stearns' Hong Kong office, doing deals with Chinese companies. . . . **Audie Hittle**, SM '91, had dinner with a group of MOT alumni and friends at a restaurant in Cambridge. The group included **Soo Sheung (Wong) Kite**, SM '91, **Alex Karpovsky**, SM '91, as well as spouses and friends. **Naoki Yamamoto**, SM '91, asked to pass on his regards to other MOTs and noted that MOTs in Japan are very active as well, typically meeting around three times a year. "Let's all do our best," Audie asks, "to stay in touch and strengthen the global MOT network. . . . **Paul Tyra**, SM '82 (II), SM '93, stopped by to see Rochelle. He and Wendy are proud and busy parents of identical twin boys born May 26, 1994. Evan Robert and Charles "Chad" Thomas. With 2-year-old Elizabeth and Wendy continuing to work part-time, Paul says it took six weeks just to mow the lawn! Paul is currently product manager for AccuFab Systems out of Corvallis, Ore. He remains based in Boston, but travels a great deal. In fact, he has recently seen classmates **Dave Beecham**, SM '93, **Joe Londa**, SM '93, **Rita Jedrziewski**, SM '93, and **Josh Lindsay**, '80 (II), SM '93. Paul promises photos of the boys soon! . . . **Emmanuel Henry**, SM '93, and his wife, Michelle, now have a new baby: Bastien, who was born June 9. They also had a visit from **Matthew Tsien**, SM '93, and **Francis Yeoh**, SM '93. . . . Rita Jedrziewski, SM '93, e-mailed the Program Office to say that she is now back at work at IBM after the arrival of Kira Elizabeth in November 1993. She tells us that "Kira is a great kid, and she, Dan, and I are all doing fine." Rita now has an assignment in a group focusing on re-engineering and cost-reduction for the IBM East Fishkill site. Rita finds the work challenging and interesting. . . . **Nevin Summers**, SM '93, is now "in the middle of a gene therapy startup doing anti-cancer and anti-viral development." He tells us that the MOT thesis as a "vehicle to network" works beautifully. Nevin had researched the commercialization of gene therapy during his year at MIT. . . . **Rajiv Desai**, SM '94, is now back at Jet Propulsion Labs in California, where they find him to have become somewhat of an "East Coaster." He wrote us recently to thank us for "one of the most memorable years of his life." . . . **Peter Tertzakian**, SM '94, has joined the firm of consultants where he will be establishing a new MOT practice. He feels that he will be drawing on everything he learned over the past year. He is with Western Management Consultants in Calgary, Alberta.—MOT Program, MIT, Room E56-290, Cambridge, MA 02139.

XVI AERONAUTICS AND ASTRONAUTICS

Robert C. Seamans, Jr., Course XVI senior lecturer, has been selected to receive the Arthur M. Bueche Award "for a lifetime career of technological leadership in aerospace and public service in guiding national policies and programs in the field of aerospace, defense, and energy. The award, distributed by the NAE, recognizes "statesmanship in the field of technology" as well as active involvement in determining science and technology policy, promoting technogical development, and contributing to industry-government-university relationships.

Robert Seamans

Brad Parkinson

The award consists of a gold medallion and a certificate. . . **Brad W. Parkinson**, SM '61, professor of aeronautics at Stanford, has been awarded the Pioneer Award by the IEEE for his groundbreaking work with global positioning systems. Parkinson, then a USAF colonel, was the original program director for NAVSTAR GPS, during the first six years (1972–1978). He led the effort to define the system, and then to sell the concept, develop it, and perform the first field tests for the Department of Defense. Since retiring from the USAF, he has been VP for advanced development at Rockwell Space Systems Group, a VP and general manager for Intermetrics subsidiary called PlantStar. Since 1984 he has been at Stanford, and has directed the Relativity Gyro Program, which is the largest program NASA has delegated to a university. . . . **Otis C. Ferrell, Jr.**, SM '53, is chairman of the board of directors with the American International Charolais Association for 1994. . .

CORRECTION: **Howard M, Schwartz**, SM '82, PhD '87 (II), was erroneously reported to be deceased in the August/September issue of *Tech Review*. Mr. Schwartz assures us that he is happy, healthy, and living in Ottawa, Ontario, Canada. He is an associate professor in the Department of Systems and Computer Engineering at Carleton University in Ottawa. His research interests include robot control, adaptive control, process control, neural networks, and vision systems. He is married with two children. We apologize for the error.—*Ed*

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XVII POLITICAL SCIENCE

Ralph Braccio, '81 (X), SM '83, sends e-mail: "I received a special appointment to the World Bank to promote and coordinate environmental investments in Central and Eastern Europe. The position was created to support the efforts of the U.S. and several Western European countries resulting from their commitments made at the 1993 environmental ministerial conference in Lucerne. I can be reached at the World Bank via <rbraccio@worldbank.org>."

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XVIII MATHEMATICS

Frederic Yui-Ming Wan, '59, SM '63, PhD '65, director for the Division of Mathematical Sciences at the NSF in Arlington, Va., and professor of applied mathematics and mathematics at the University of Washing-

Burchard Scholars Program

A Venue for the Intellectual Life

Historian Bruce Mazlish wasn't the first faculty member to observe that MIT students with broad interests and talents had plenty of outlets for their interests in science and technology, but when it came to their passion for subjects like language, history, or the arts, they "felt lonely and isolated." Says Mazlish, "They went back to the dorms and there wasn't a critical mass to consult with."

Almost 10 years ago, however, Mazlish had an idea for improving the situation: he proposed that MIT provide these students with "intellectual and social feasting"—regular encounters with faculty over good food, perhaps a glass of wine, and, most importantly, lively conversation. The late Ann Friedlaender, PhD '64, dean of the School of Humanities and Social Sciences (SHSS) at the time, offered both encouragement and a budget for such a program, and Mazlish enlisted colleague Phillip Khoury (now the dean) to work with him. They decided to name the group after John Ely Burchard, '23, the first SHSS dean and an early advocate of interdisciplinary education at MIT.

The program offers a wider set of experiences of "what humanists are about, what we do," Khoury says. Ideally, the scholars will make connections among themselves, strike up friendships, and develop a community of interests. "Our hope," he adds, "is that they will take what they have learned 'across the Rubicon' to other undergrads"—in other words, that their love of the humanities will be contagious.

Each fall, SHSS invites juniors and seniors to apply to the Burchard Scholars Program, providing one letter of recommendation from an SHSS faculty member and a 500-word essay. The scholars are chosen by a faculty committee chaired by Khoury. The program gets under way in February with a welcoming reception and includes monthly dinners and seminars over the calendar year.

MIT STUDENTS WITH A PASSION FOR THE HUMANITIES NEED HELP IN IDENTIFYING A CRITICAL MASS OF COLLEAGUES.

Between 20 and 25 scholars assemble for the dinner/seminars in a comfortable room in Bldg. E51, along with a number of SHSS-faculty guests and a speaker whose presentation gives energy and direction to their conversation.

The wide appeal and distinctive MIT character of the presentations were evident at the last dinner/seminar of spring 1994: Professor Peter S. Donaldson, head of the literature section, discussed his progress in using the computer to advance Shakespeare studies by integrating text with films, photographs of stage productions, and other media. The way Donaldson touched on a diversity of fields intrigued scholars such as Yumi Oshima, '95, a nuclear engineering major who identified herself as a composer, and Philip William Tracadas, '95, a double major in earth, atmospheric, and planetary sciences and management who aspires to make movies in far-flung locales.

Jonathan Bierce, '94, a 1993 Burchard Scholar who graduated in May with a bachelor's degree in physics, was attracted by the promise of stimulating intellectual conversation, "which I don't get enough of," he remarked. "The faculty speakers, guests, and other students were interested in just about anything and could talk about anything. I met people that I wouldn't have seen otherwise." Institute Professor Noam Chomsky, who spoke on President Clinton and the "new world order," won Bierce's vote as the most impressive of the speakers for 1993; he recalls that he was "stunned" by Chomsky's command of his topic. When Chomsky speaks in one of MIT's large lecture halls, it's often standing-room-only, but the Burchard gathering allowed real discussion among the few dozen people in attendance.

Patrick Cashman Andrus, '94, who received an SB in linguistics, was another 1993 Burchard Scholar, and he says that he never missed a seminar. Though impressed by every speaker, Andrus says he was particularly intrigued by Professor Merritt Roe Smith, the director of the Program in Science, Technology, and Society, who discussed the evolution of the Civil War armory industry into the manufacturing of bicycles and automobiles. □

—*STEPHANIE V. GREPO*

The author is program manager in the Graduate Alumna/ae Program.

ton, has been selected vice chancellor of research and dean of graduate studies at the University of California/Irvine. His role is to help faculty direct research toward funding sources and help move UC/I into the top 50 research universities in the country. Wan will be responsible for research policy, allocation of campus research and graduate fellowship funds, and contracts and grant development. Wan served on the MIT mathematics faculty until 1974, when he was appointed professor of mathematics and the first director of the Institute of Applied Mathematics and Statistics at the University of British Columbia. He then joined the University of Washington as the first department chair of applied mathematics and served as associate dean for natural and mathematical sciences of the College of Arts and Sciences from 1988 until his current NSF position began in 1993. Wan is an internationally known expert in the theory of plates and shells, a field of structural mechanics. Among the many applications of the theory is his design analysis of the corrugated Tupperware Astroflex Seal. Wan's other research interests include mathematical problems in resources management, urban land economics, and neurons under random excitations.

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XX APPLIED BIOLOGICAL SCIENCES

Bassima Saleh Alam, SM '64, died on July 2, 1994. According to an obit that ran in the *New Orleans Times Picayune*, Alam was a biochemist. She worked at Tulane Medical Center before going to Louisiana State University Medical Center, where she spent most of her career. Her research was in nutritional biochemistry, especially the effects of nutritional factors on cancer.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

XXII NUCLEAR ENGINEERING

Navy Captain **Thomas J. Kelley**, SM '69, NE '69 (XIII), recently retired after 30 years of service. Kelley most recently served as the commanding officer of the Naval Sea Support Center Pacific in San Diego. During his tour as commanding officer, the center often earned recognition for its exceptional technical and logistics support to the Pacific Fleet. For excellence in retaining high-quality personnel, the command earned the Naval Sea Systems Command "Golden Anchor Award" for two consecutive years. During Kelley's naval career, he served aboard a variety of ships, including cruisers, destroyers, and aircraft carriers, as well as at shore duty assignments, around the world. Among his personal awards and decorations are the Legion of Merit, the Meritorious Service Medal, the Navy Commendation Medal, and varous campaign, unit, and service ribbons.

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TPP TECHNOLOGY AND POLICY PROGRAM

Jean-Bernard Caen, SM '81, started up Finance and Technology Management, to work with banks and help them understand and manage the risk in their portfolios. He reports that 1994 looks like a super year for him. . . . **Alain Levy**, SM '87, was recently made director general of a new company (SBNM) that sells and distributes Nestle and other brand-name food products in Russia. . . . **Patrick Ferraris**, SM '87, married Patricia on June 17, 1994. He continues working for Boussard Consultants in Paris. . . . **Jean-Marc Monguillet**, SM '87, has just moved to the Campagne Generals des Eaux, the French conglomerate water utility. . . . **Sylvia Marin-von Koller**, SM '88, continues to hold the position of regional advisor for environmental policy and strategic planning of the Proyecto Ambiental para Centro America (the Central American Environmental Project) since July 1993. This project is a joint venture between CARE and the Nature Conservancy and works in partnership with 19 local non-governmental organizations in Belize, Guatemala, Honduras, and Costa Rica. . . . **Mia Paget Bosquet** . . . '84 (II) SM '89, splits her time between her two daughters and Euregis Consultants, her husband's risk management firm. She reports enjoying living in the south of France. . . . **Bryan Moser**, '87 (VI), SM '89, received the 1993 United Technologies Outstanding Achievement Award for leadership in developing a strategic research and management base in Japan.

Joan Winston, '72 (VIII), SM '82, has been promoted to senior associate at the Office for Technology Assessment. . . . **Alan Buzacott**, SM '90, stopped by the TPP office in July. He is still on staff as an analyst at the Office of Technology Assessment and is currently working on wireless communication. . . . **Mark Roberts**, SM '90, left the Office of Technology Assessment to assume a journalist position with the *Economist*, writing on science and technology issues. . . . Elizabeth and **Jerry Sheehan**, '86 (VI), SM '91, will be losing some sleep—Scott arrrive in June 1994. . . . **Francois Cohas**, SM '93 (XVI, TPP), is engaged to be married in 1995. Congratulations Francois and Amy! . . . Last spring, **Eric Kim**, SM '93, organized seminars on sustainable development for engineering schools in Paris, featuring among others a presentation by Professor Joel Clark, SM '75 (XV), ScD '72 (III). . . . **Jerome Muller**, SM '93, works with a team from the French Ministry of Industry that helps small companies (PME) perform effective business planning and technological innovation. . . . **Jane Song**, '91 (III), SM '93 (III, TPP), spent the summer working at Choate, Hall, and Stuart, a leading law firm in Boston—quite an honor for a first-year law student. . . .Marcia and **Paulo Bellotti**, SM '94, have a son—Marco arrived in April 1994. Best wishes to all. . . . **Chris Houlahan**, SM '94, has an addition to her family. Carly Deane joined big sister Molly in July 1994. . . . **Liz Stock**, SM '95, has spent the summer in Ghana and reports research is going well. She has been able to interview contractors, their supervisors, and casual laborers. After spending five weeks in Ghana, Liz will be traveling to Kenya, Tanzania, and Zimbabwe.—Richard de Neufville, TPP, MIT, Room E40-252, Cambridge, MA 02139.

Deceased

The following deaths have been reported to the Alumni/ae Association since the *Review* last went to press:

James S. Munro, '22; March 1994; Newton Center, Mass.
Walter J. Bagby, '24; April 7, 1994; Phoenix, Ariz.
Hartselle D. Kinsey, SM '24; July 9, 1994; Scarsdale, N.Y.
Malcolm S. MacNaught, '24; May 30, 1994; Manchester, Conn.
George P. Edmonds, '26; January 16, 1994; Wilmington, Del.
Lathrop B. Merrick, SM '27; June 16, 1994; Durham, N.H.
Milton Bearg, '27; July 16, 1994; Torrance, Calif.
Edward R. Stevens, '28; June 9, 1994; Trenton, N.J.
Willard J. Slagle, '29; SM '29; August 13, 1994; Plymouth, Mass.
Robert K. Mueller, '32, SM '34, ScD '36; August 4, 1994; Paradox, N.Y.
Charles P. Britton, '33; July 6, 1994; Needham, Mass.
Benjamin Liberfarb, '33; June 13, 1994; Waltham, Mass.
Joseph S. Chenette, '36; June 23, 1994; Ridgewood, N.J.
Frederick Philips Pike, SM '36; 1993; Raleigh, N.C.
Polly Povey Thompson, '38; June 26, 1994; Portland, Ore.
Antonio W. Diokno, SM '39; July 15, 1993; Makati, Philippines
Richard D. Martin, '39; July 8, 1994; Marblehead, Mass.
Theodore H. Talbot, Jr., '40; May 30, 1994; Chatham, Mass.
Robert S. Lundberg, '41; December 29, 1992; Bronxville, N.Y.
Harold F. Ring, '42; 1980; Rockland, Del.
Gustavo A. Calleja, '43; January 1993
Kenneth R. Wadleigh, '43, SM '43, ScD '53; July 21, 1994; Swansea, Mass.
Edgar P. Eaton, Jr., '44; July 19, 1994; Convent Station, N.J.
Edgar J. Moor, '44; July 1, 1994; Cambridge, Mass.
John Mitchell, '45; August 10, 1994; Cambridge, Mass.
John C. Martin, '47, '48; July 15, 1994; Mercer Island, Wash.
Charles H. Neuhardt, MAR '47; 1994; Midland, Tex.
Samuel Nairn Karrick, Jr., '48; April 23, 1994; Arlington, Va.
Benjamin F. Lohr, '48; October 18, 1993; Silver Spring, Md.
John F. Riordan, Jr., '48; May 19, 1994; Ann Arbor, Mich.
John Clymer, MAR '49; 1993; Natick, Mass.
John P. Regan, '49; 1993; Houston, Tex.
James A. Daley, '50; June 17, 1994; Simsbury, Conn.
George Kirby Dawson, '50; June 27, 1994; Menlo Park, Calif.
Jack R. Martin, '50; June 18, 1994; Bedford, Mass.
George W. Hughes, '51, SM '52, EE '55, ScD '60; December 10, 1993; Brookline, Mass.
William B. Pohlman, Jr., PhD '51; January 1993; Northridge, Calif.
James A. Klupar, '53; 1994; Sun City, Ariz.
Yohay Ben Nun, '54; June 6, 1994
Gordon N. Smith, '54; August 3, 1994; Wolcott, Conn.
Ronald R. Marston, '56; 1993; Kennewick, Wash.
John T. Hughes, Jr., '57; July 27, 1994; Wellesley, Mass.
Peter R. Metz, SM '58; June 10, 1994
William G. Lewis, '64; May 15, 1994; Kennett Square, Pa.
Bassima A. Saleh, SM '64; July 2, 1994
Theodore E. Hlavac, Jr., SM '66; 1993; Oakmont, Pa.
Edward C. Wert, '66, SM '69; April 22, 1994; Downingtown, Pa.
David G. Lyons, '68; February 12, 1994; Elsah, Ill.
Albert J. Booth, Jr., '69; 1994; Richmond, Va.
John D. Stubbs, SM '71; June 7, 1994; Paget, Bermuda
Robert A. Lentz, '72; April 1993; Encinitas, Calif.
Mark Lane Radtke, '73; July 24, 1994; Wellesley, Mass.
Jeffrey L. Star, '75; June 20, 1994; Goleta, Calif.
George A. Divers, III, SM '76; September 1993
Mark B. Fefferman, '77; June 25, 1994
David G. Biron, PhD '81; June 24, 1994; Chelmsford, Mass.
Rush H. Record, '82; October 16, 1993; Houston, Tex.
Jens T. Jensen, SM '83; April 14, 1994; Perkinsville, Vt.

CORRECTION: Howard M. Schwartz, SM '82, PhD '87, was erroneously listed as deceased on page MIT 54 of the Aug/Sept 1994 Technology Review. *Mr. Schwartz has notified us that he is alive and well in Ottawa, Ont., and is a professor at Carleton University. We apologize for the error.—Ed.*

PuzzleCorner

Well, I survived another vacation! Each August, we go for two weeks to Sandy Island in Lake Winnipesaukee, a family camp run by the Boston YMCA. My main goal is to avoid embarrassing myself in either of the Sunday camper/staff softball games (i.e., not striking out or making too many errors). This is getting more important each year as my Little League sons are waiting to pounce. Well I did all right the first week and had to drive my wife, Alice, to the airport on the second Sunday so was relieved—until I returned from the airport to find that my 12-year-old (one year shy of the minimum age for participation) was "famous." He was somehow playing third in the game and a bad hop hit him just below the eye. Fortunately, he just had a bad swelling and, even more fortunately, it was almost gone when we arrived home six days later.

Problems

N/D 1. Larry Kells writes that while kibitzing a high-stakes game, he saw declarer bid and make 7 no-trump redoubled and vulnerable. In the aftermath, the defenders, a married couple, were arguing heatedly:

Wife: How many times do I have to tell you to stop making those risky speculative doubles? You've cost us thousands of dollars that way!

Husband: But I had 26 points. I thought I could beat 7 no-trump.

Wife: You see perfectly well that we had no defense. Next time don't double 7NT in that position unless you have all 4 suits completely stopped!

Assuming they were both telling the truth, reconstruct the deal.

N/D 2. Nob Yoshigahara wants you to solve the following criptarithmetic problem.

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO: ALLAN GOTTLIEB
NEW YORK UNIVERSITY
715 BROADWAY, 10TH FLOOR
NEW YORK, N.Y. 10012,
OR TO: GOTTLIEB@NYU.EDU

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                A
               AA
              AAA
             AAAA
            AAAAA
           AAAAAA
          AAAAAAA
         AAAAAAAA
        ---------
         BCDEFGHI
```

N/D 3. Martin Kalinski, a former Baker House colleague, asks a common question about palindromes. Kalinski reminds us that a palindrome is a positive integer that reads the same right to left as left to right. For example, 121 and 1331 are palindromes. Take a non-palindrome like 57 and add to its reverse: 57 + 75 = 132. Keep going and get 132 + 231 = 363, which is a palindrome. Will this procedure always yield a palindrome? Note that it is easy to find numbers that do not yield a palindrome after two applications of "adding the number to its reverse." The question: is are there any numbers that never yield a palindrome?

Speed Department

Larry Kells wonders if you know an English word with a quadruple letter?

Solutions

Jul 1. Jorgen Harmse is greedy. He wants South to make a bid of 1NT redoubled with 6 overtricks (for the highest possible declare score) against best defense after a reasonable auction. Your editor is not a Bridge guru but when I become omnipotent you will get more points for bidding and making 7NT redoubled than for bidding 1NT redoubled and making 7.

The following solution is from Robert Holt: North-South are playing weak no trumps, so South (assume South deals with both vulnerable) opens 1 no trump. A popular way of dealing with weak no trumps is to double with the top of the no trump range. Say East-West have agreed to double with 13+ high card points, so West doubles. Now N-S play Brozel runous, so North passes. If East-West remain silent, this forces South to redouble, and then North either passes with a strong hand or bids his long suit with a one-suited hand. (Two-suiters by North are shown with two-level bids or an immediate redouble.) East has nowhere to go, so East passes. South redoubles, and West, who thinks his or her kings are well placed and has a natural diamond lead against no trump, also passes. Now North decides that his hand is strong enough to sit for the redouble, and passes. East knows that E-W have half the high card points and doesn't have a decent suit to run to, East passes as well. Now South makes all 13 tricks by finessing as deeply as possible whenever clubs and spades are played.

	North ♠ A Q T 6 5 4 ♥ A 6 5 ♦ 7 6 ♣ 5 4	
West ♠ K J ♥ K 9 8 7 ♦ K Q J T ♣ 8 7 6		East ♠ 9 8 7 ♥ Q J T ♦ 5 4 3 2 ♣ K J 9
	South ♠ 3 2 ♥ 4 3 2 ♦ A 9 8 ♣ A Q T 3 2	

Jul 2. Nob Yoshigahara wants you to find three positive integers. 1) The smallest integer having the property that the first 10 digits of its square root are unique. 2) The smallest integer whose square consists of 10 digits all unique. 3) The smallest integer having the property that the first 10 digits of its reciprocal are unique.

I agree with the proposer's solutions, namely 1362, 32043, and 38. Robert Holt obtained the same solutions but adds that if leading zeros are not permitted for #3, the answer is 648. Holt also notes correctly that I should have said "distinct" rather than "unique."

Jul 3. Timothy Maloney is not at all afraid of sunburns.

Just before a business trip to Manila (14 degrees N latitude) around the end of April, I calculated that the sun should be directly overhead around noon, and indeed it was. For a spherical earth in a circular orbit around the sun with the earth's axis tilted at 23 degrees with respect to its orbital plane, find an exact trigonometric expression to give the latitude at which the sun is directly overhead (around noon) as a function of time of year.

James Abbott sent us the following fine carefully drawn solution (see page MIT 40):

It can be shown by geometry that if a point on the earth's surface has the sun directly overhead, the latitude of the point is equal to the sun's declination. This quantity varies throughout the year and, for the real Earth, is tabulated in various almanacs. Our job then becomes one of deriving an expression for this same quantity for the fictitious earth described in the problem.

Continued on Page MIT 40

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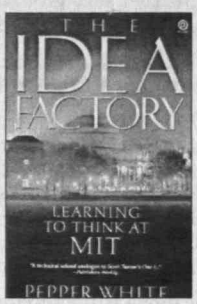

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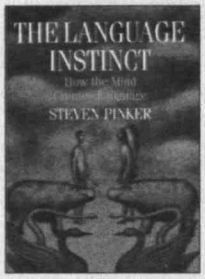

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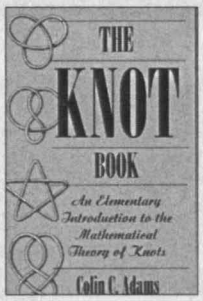

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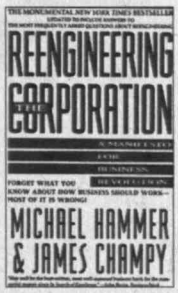

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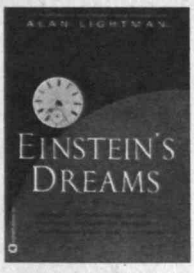

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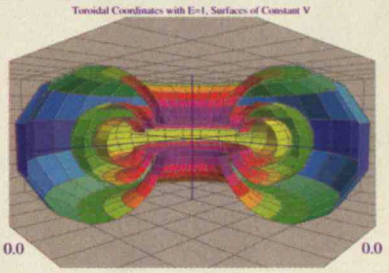

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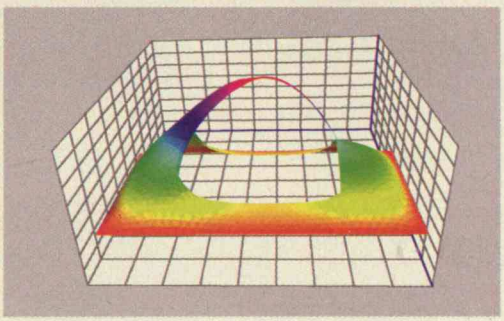

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THE NUMBER

BY ALAN LIGHTMAN

He stands up from the boxes and looks out the window. To the east, in the distance, rises the steeple of a chapel, fragile and faint. The light changes. A cloud drifts over the sun. Then the sun is uncovered again, the little room fills up with light. He lets down the blinds but keeps the slats open. Strips of light slide from the wall to the floor. He returns to his boxes, unpacks. A set of keys. A faded photograph of a young woman with auburn hair. Two old

ILLUSTRATIONS BY STEPHAN DAIGLE

A YOUNG SCIENTIST ON A MISSION ENCOUNTERS

A BIG MAN OF PHYSICS AND A SLICE OF LIFE.

letters from his friend John. These last things he puts carefully in a drawer. Most of the boxes are books. He stacks them against the wall, the muscles flexing in his arms. The room darkens as another cloud passes over the sun, lightens, darkens again.

Now he lies on the upholstered couch in the corner. He begins writing. He writes on a white pad of paper, wavy lines and strange signs, mathematical symbols. He closes his eyes for a while, begins writing again. Someone knocks at his door, but he doesn't hear. He imagines corrugated surfaces, magnified again and again. He calculates and imagines, while the room glows and dims and the sun slides slowly across the floor.

"Dr. Lang, let me say again that it's good to have you on the faculty," says the dean. Bennett smiles. The dean, a historian, is small but long, with a thin, tubular neck that protrudes far beyond his collar. His eyes lie close together. He has the manner of an animal accustomed to darkness and damp.

"A fine discipline, physics," says the dean. "A fine discipline. And a fine department of physics we have here at Leominster." Bennett nods and remains standing. The dean offers the new assistant professor a licorice from a glass jar on his desk. Bennett puts it in his pocket. "You like basketball?" says the dean. Bennett shrugs his shoulders.

"A fine department of physics we have here," the dean repeats, playing with his pencils. "Lang, you've no idea what it takes to keep a college like this afloat. The Harvards and the Yales, they can sit back on their fat, pompous reputations, and the money keeps flowing into their coffers. Arrogant sons of bitches. But a small, honest college like Leominster must continually prove its excellence." The dean pauses, eyeing Bennett carefully as if trying to decide if he understands anything besides physics. Just then, the dean spills his pencil leads on the floor. "Sally," he whines loudly. A woman appears at the door. The dean looks at her, hesitates. "Sally, would you run out to Sables and pick up my shirts." "Certainly, Professor Kramer," says the dean's secretary. "And make sure they didn't starch the shit out of them like last time," says the dean.

The dean appears to be concentrating on something. Minutes pass, or perhaps only seconds. Then he says to Bennett, "Are you familiar with the work of Arnold Scalapino?" "Of course," Bennett answers. "You know that Professor Scalapino is on our faculty," says the dean. "Perhaps that's why you accepted our offer." The dean's thin lips part in a smile of satisfaction. Bennett stares at the floor. He wants only to finish unpacking his boxes and to prepare for his first classes, three days away. "We have a little problem with Scalapino," continues the dean. "He hasn't published anything for ten years."

Bennett is well aware of Scalapino's publication record. It's part of the legend. Scalapino doesn't publish. Scholars suspect that Arnold Scalapino has performed reams of calculations but detests to waste time writing up his results. In fact, Scalapino's entire reputation rests on two short papers from conference proceedings, one in 1959 and one in 1965. At each of those assemblies, the reclusive physicist appeared unexpectedly, delivered a terse and brilliant lecture, then vanished. Each of his two lectures, transcribed by admiring students and exhaustively studied for years, altered the course of physics in its area. A single footnote in the second paper led to what eventually became called the Scalapino quantum instability. Maddeningly, both of Scalapino's papers hinted at further, unproven results, revolutionary ideas perhaps calculated and codified on wrinkled scraps of paper lying about Scalapino's office somewhere. Or perhaps not. Scalapino himself has never been available for queries. He doesn't answer his phone.

"We hired Scalapino a decade ago," says the dean softly, baring his yellow teeth. "He

ALAN LIGHTMAN is professor of science and writing and senior lecturer in physics at MIT. This story is excerpted from his new novel Good Benito, *to be published by Pantheon Books in January 1995. Lightman's most recent book is* Einstein's Dreams *(Pantheon Books, 1993).*

comes to college one day a week, to preside over a seminar, and then disappears. He doesn't come to faculty meetings. He doesn't serve on committees. He doesn't supervise students. And he hasn't produced one goddamned piece of work. That sly bastard swindled us. He talked the provost into giving him the highest salary in the college, and he hasn't published one goddamned paper. Who the hell does he think he is?"

The dean slides back into his suit, then lowers his voice still further to a whisper, almost a hiss. "Lang, do you understand what a Nobel Prize would mean to Leominster, what endowments we could get with a Nobel?"

"Is Scalapino still working?" Bennett asks. "Isn't he in his fifties now?" The dean's eyes narrow. "It doesn't matter if he's still working." "What do you mean?" Bennett asks. "It's all in his file cabinets," says the dean. "He's got twenty years of unpublished work written down and stored in his files." Bennett is stunned. Twenty years of Scalapino's work, if it truly exists, could turn modern physics on its head. The results of the first decade have probably been rediscovered by now, but those of the last could be completely unknown. Bennett cannot comprehend the possibilities. He sits down for the first time.

The dean notices his new faculty member's reaction and smiles. "We know what Scalapino has been hiding from us," he says. "Three years ago, I sent Garfund to Scalapino's house to talk to him. Garfund spotted the file cabinets there, in the study, crammed with pages of equations. That fool Garfund," shouts the dean. "He threatened Scalapino. How could I have made such a fool the chairman of the physics department? You don't threaten a sly bastard like Scalapino. You coax him." The dean pauses. Then: "Lang, I want you to go get those files. Will you do it?"

Bennett has forgotten his boxes. Visions of new branches of physics flicker through his mind. "Yes," he hears himself say. Yes, he will put aside his own research for several months to do this fantastic thing. "Good," says the dean. "You've got nine months. In May, our trustees convene, and I want to place some of Scalapino's work in their paws, ready for publication. Do you understand? You've got nine months." Bennett nods.

"Good," repeats the dean. "I correctly sized you up as an intelligent young man. Scalapino lives in Fells Point. Here's his address." The dean scribbles something on a piece of paper and hands it to the young physicist.

A week later, Bennett makes his first visit to Scalapino's house in east Baltimore, near the harbor. He parks his car and walks up the street. Red-brick row houses nestle oddly between bars, shoe shops, cafés, glass companies, bookstores, pizza parlors. Artists and musicians live in Fells Point, in a great cauldron of ethnic groups: Germans, Italians, Poles, American Indians. Being near the ocean, the area provides a natural entry point for immigrants. And the seamen come ashore. The streets are littered with bars like the Horse You Came in On and the Cat's Eye Pub. Shouts and saxophone music pour out from open windows and the air is warm and Bennett's shoes click pleasantly as he walks. The streets are paved in Belgian block, a smooth kind of cobblestone once used for ballast in the great sailing ships.

He stops at a three-story red-brick house on Aliceanna Street. A rusting metal gate stands in front of half the house, leaving the other half exposed to the street. It is midafternoon. He knocks for a long time. He knocks and sweats a little in the warm air and only half believes he is standing at Arnold Scalapino's house when a pretty, dark-haired woman in her late twenties finally answers the door, opens it just enough to see him. "I'm Bennett Lang, the new assistant physics professor at Leominster," he says smiling. "I've come to see Professor Scalapino." "What do you want with him?" says the young woman. "He's very busy." "I just wanted to say hello," Bennett says anxiously. "He's busy," the young woman repeats and closes the door firmly.

Bennett goes back to his cramped office at Leominster. He pulls down the blinds and lies on his couch. He begins examining the cracks in the ceiling. They branch out like tributaries of a river, or veins of a leaf. They wander, connect, then separate again, delicate patterns unobserved until this moment. Who is that woman who

guards Scalapino? Through the crack in the doorframe, he saw she was holding a book. Perhaps she is a reader. He will buy her a copy of Lucien's *Tactile Mountains* and return to Fells Point.

"Mr. Lang again," the young woman says, irritated. "I told you he's busy. Good afternoon, Mr. Lang." She begins closing the door. At least she remembered his name. Bennett quickly thrusts the book through the crack in the door, into her hand. She looks at it. Her frown softens. "May I come back?" he blurts out. She hesitates, looks again at the book, then at Bennett. A man's voice, baritone and distant, floats from a neighboring house. "Try next Thursday, after ten in the evening," she says and shuts the door. Bennett strides happily around the half-gate and spends an hour walking through the cobblestone streets. On some impulse, he buys a green crystal thimble.

Fells Point at night is alive. Men and women drift singly and in pairs through the streets. Music floats in the warm, colored air. Two women with shopping bags argue loudly under a streetlamp. A man staggers under the weight of three cases of Shawney Girl beer.

The woman in Scalapino's house lets Bennett in. She introduces herself as Sophie, Scalapino's daughter, and leads Bennett up a curving flight of stairs. It is narrow and close and the walls are decorated with pages from an old calculus book. After reaching the top, Sophie turns left, and they immediately enter a kitchen smelling of smoked herring. There, bent over the kitchen table with a pad of white paper, is a monstrously fat man. Arnold Scalapino. He seems wedged in his seat, his huge belly straining upward against the underside of the table. Great rolls of pink flesh hang around his neck. He looks up when Bennett walks in and indicates with his huge hand that he should move to the other end of the table.

Bennett sits down and fiercely pinches his leg under the table. "Yes, I'd heard there was a new man in the department," says Scalapino. "Now we're back up to three." His voice is surprisingly high pitched. Sophie leans against an old Westinghouse refrigerator, watching them. "Uh, I just finished my doctoral work at Blaine, with Davis Jacoby," says Bennett, praying that Scalapino will recognize the name of his thesis adviser. "Ah, yes, Davis Jacoby," Scalapino squeaks. "He did some fine work on space-time singularities. Tell me about your thesis problem." Scalapino waves the young physicist to the blackboard that stands oddly in the corner of the kitchen.

Bennett has lectured on his thesis many times before. He picks up the chalk and his fright disappears. But he has barely begun when Scalapino asks him two questions. The first question he answers without trouble. The second he struggles with. Scalapino has swiftly bracketed Bennett's knowledge. After the second question and Bennett's labored reply, the older man snorts, drops his huge head, and resumes pondering the equations on his white pad of paper. He does not look up again. After a minute, Sophie politely informs Bennett that her father is now occupied and she will show him to the door. The interview has lasted fifteen minutes.

He withdraws. He disappears into the sleepy folds of the college, happy to be alone in this town where he knows no one, to return to his own work and his solitude. He again takes up his calculations. He counts cracks on the ceiling in his office. He goes to his classes, meets with his students on the small upholstered couch. The air turns cooler and he begins wearing his green jacket and noticing the blood-red leaves of the maple outside his window. Several times over the next couple of months, he goes back to 137 Aliceanna Street on Thursday evenings. Each time, he is turned away at the door by Scalapino's daughter, who repeats that her father is busy or thinking or otherwise occupied.

In late November, Sophie unexpectedly lets Bennett in, as if no time has passed. She takes him up the winding stairway with the equations on the wall. The kitchen is empty. He stands alone at the top of the landing, Sophie having vanished, when he hears a squeal. It is Scalapino, saying, "Now that is a nontrivial move." Following the voice, Bennett walks down a long hallway and into a brightly lit room, where he discovers ten chess games in progress. Scalapino is studying one of the boards, grinning broadly. "A nontrivial move," he repeats. Against one wall sits a computer. Scalapino is playing the computer. Sophie, who soon comes to the door, explains that her father has programmed the computer to generate moves from random numbers, subject only to the rules of the game and the current positions of the pieces. The vast majority of random moves are preposterously silly, but every once in a while the computer makes a truly brilliant choice, which keeps Scalapino engaged for half an hour. Evidently, such a profound accident has just occurred.

After a few minutes, Scalapino looks up from his board. "You're persistent, Lang. But not offensive. I like that." Bennett decides to seize his opportunity. He states his mission, tactfully but with no wasted words. Scalapino looks at him suspiciously.

Bennett's eyes wander. From where he is standing, he can see across the hall into another room, dimly lit, and thinks he can make out the shadowy shapes of a file cabinet.

"My notes are only for my own pleasure," says Scalapino. "Then you do have notes?" Bennett says, unable to blunt his excitement. "Yes," says Scalapino, waving carelessly in the direction of the other room, "But I'm not interested in dollying up my notes. Once I see how to get to the end of a problem, it's time to start something new. That's the fun of it."

Scalapino immediately begins telling Bennett about his current project, something called string theory, dealing with subatomic physics. Bennett cannot think about string theory at this moment. He pleads again with the great physicist. "You don't realize the importance of your work," he says. "I'll go through your notes, I'll write the papers for you. It would be an honor."

Scalapino snorts and rotates the great dome on his shoulders and exchanges glances with his daughter. A tentative look comes over his pasty white face. "So you were a student of Jacoby's?" he says. Bennett nods. Scalapino looks again at his daughter. He scratches his eyebrows. "All right," he sighs. "All right. But the files don't leave the house. Sophie, take Dr. Lang to the study and show him the files." Then Scalapino stands up and waddles down the hall to the kitchen and his white pad of paper.

Bennett follows Sophie into the study. There they are. Scalapino's files. He opens the first file. It is labeled "Radiation from Accelerated Event Horizons" and contains many pages of equations. He opens the second: "Percolation in N Dimensions." More pages of calculations. A third: "Modifications in the Wheeler-DeWitt Equation for Quantum Superspace." Bennett sinks into a chair, unable to speak. "You look tired," says Sophie. "Come back tomorrow night."

The next night, Sophie takes Bennett immediately to Scalapino's study. In the lamp light, he can see that back issues of the *Physical Review* are piled up on the windowsill, on the desk, on the floor. Shoes are used as bookends, often not in matching pairs. Unopened letters from Lapides, Mortenheim, Kaiser, Temin litter the desk. Jars of peanut butter sit in half-open drawers.

Bennett pulls out the first file and starts to read. The pages are wrinkled and darkened with coffee stains and not in any order. Mathematics dominates the words, which peer tentatively among equations like timid forest animals. Most of these few furtive words are of the species of, "It obviously follows that," or "Thus," or "An excellent approximation is." Bennett stares out the window, at the streetlights below, and realizes that he will have to rederive the equations. It will be tedious and difficult, for Scalapino has skipped many steps between one equation and the next. And there are none of the usual references to prior results or articles in journals.

Indeed, as Bennett soon learns, Scalapino hardly ever reads the scientific literature. When he does, he looks at a paper only long enough to see what the problem is, then quickly shuts the journal, as if having glanced at an unwanted review of a film, and derives all the results on his own. On the rare occasions that he travels, he is besieged in hallways and even restrooms by other physicists, who are anxious to discuss their latest discoveries with him. After a very few minutes, they often find to their horror that Scalapino not only understands their new results, but has already calculated far more

general results, which he keeps in his file drawer and hasn't bothered to publish. This annoys some of his colleagues. Taped to the wall of Scalapino's study is a five-year-old letter from Lapides that reads simply, "Fuck You."

Bennett has been engrossed in the files for a couple of hours when the house begins shaking and rumbling. He leaps from the chair, thinking an earthquake has hit. Sophie arrives and says that a freight train is passing, a regular evening event. The trains, which move very slowly, carry chemicals and leave a fine yellow powder on the windowsills in the morning. She looks down at the desk and Bennett's work. "I'm glad you're doing this," she says softly, and then leaves. Bennett is exhausted. Apparently Scalapino and his daughter sleep during the day and stay up all night, but he is not used to these hours. He goes home to his small apartment near campus, elated but worried.

The next day, at the college, he finds a note in his mail slot, from the dean. It says, "Do you have the files? May is fast approaching. Please drop by my office at your earliest convenience." Bennett has no intention of dropping by the dean's office. In his classes that day, he feels inspired. He has gotten a glimpse of the work of a great physicist. With unusual enthusiasm, he describes to his pupils the beauty of Newton's three laws of motion. His students look at him uncomprehendingly, like cows at a passing train.

It snows. Snow is unusual for Baltimore. The streets remain buried under white blankets, the few cars that venture forth collide with each other or slide off the road. The city turns silent and white. At midday, Bennett manages to find one undaunted bus that is traveling to Fells Point. He goes to 137 Aliceanna, arriving in broad daylight for the first time in months.

He hears shouts. To his surprise, he sees Scalapino and Sophie awake and out in the street, throwing snowballs at each other and screeching like children. Scalapino wears a red woolen cap with a tassel on top. Bennett joins them. Despite his obvious pleasure, Scalapino moves slowly and with great labor, his various sweaters and scarfs bulging like drawers from a huge chest being dragged across a room. After a few minutes, he is sweating heavily and panting, and his face is as red as his hat. He sits down. "You're a pretty good shot, Lang," he says after his hard breathing subsides. "And I'm a pretty good target." He releases a high-noted giggle and pats Bennett on the back. Bennett doesn't work on the equations that evening. Instead, he and Sophie discuss Lucien and Calvino while Scalapino plays chess with his computer.

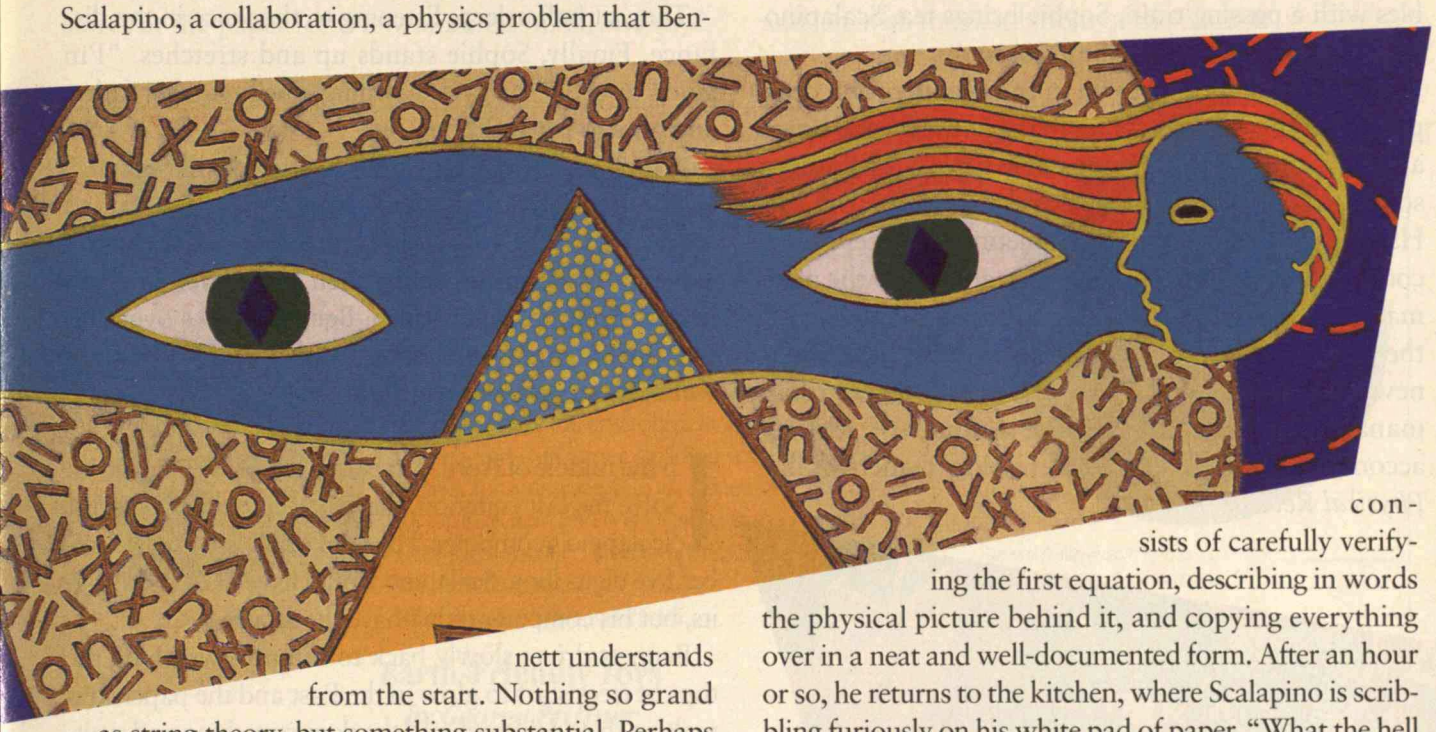
Then, Christmas vacation. Scalapino and Sophie disappear on some undisclosed trip. It is January before Bennett sees them again. When they return, he begins following the hours of the house, sleeping by day, whenever he isn't teaching, and working through the night in Scalapino's study. He finally gives up on the first file and moves to the second. Again, the pages are jumbled. He cannot follow all the mathematics. There are occasional strange diagrams that make no sense to him. Some of the calculations are written on scraps of grocery lists and electric bills and restaurant place mats. He has battled for six weeks with Scalapino's notes, and he has amassed the heaviest armaments he can find: volume two of Bjorken and Drell's *Relativistic Quantum Mechanics,* Gill and Thurbach's *Advanced Methods of Mathematical Physics,* Hammermold's *Differential Geometry and Tensor Analysis.*

One day, around three in the morning, he can bear it no longer. He goes to the kitchen and asks Scalapino for help. The huge physicist sits at the table with his eyes closed like a meditating Buddha, pure in his habitual white shirt. His closet is full of white shirts, simplifying the problem of matching ensembles. The younger man coughs, places the pile of raggedy pages down on the table, and points imploringly at a flock of equations that have seemingly migrated from nowhere. Scalapino glances at them out of the corner of his eye. "Percolation," he squeaks, "that was 1969." He waves the pages away. Sophie, who has been reading a novel in the next room, overhears the conversation and calls to her father: "Daddy, try to help." Father and daughter argue. Finally Scalapino yells, "Strings, strings, I'm working on strings. I've done percolation. I'm bored with percolation."

Bennett silently gathers up the indecipherable runes of what is probably the definitive theory of percolation and retreats to the study. The streetlights shine sharply in the cold air outside. He clears a space on the desk and puts his head down and releases the grip on his pencil. Later, he discusses the matter with Sophie. She spends a long time with her father in the kitchen. Finally she

returns to the study, where Bennett still slumps at the desk. "I'm terribly sorry, Bennett," she says sadly. "I'm sorry for everyone. My father apologizes to you, but he simply can't force himself to go back to what he's already accomplished. He's been this way for many years. I can't explain it to you. He sincerely apologizes, but he can't do it. But he hopes you will keep coming to the house. He likes you." Bennett raises his head and nods. He is beginning to realize that Scalapino's twenty years of notes will remain forever imprisoned within the walls of this room. And he will go back to his own career, publishing lesser works in profusion.

He lies on the sofa in his small office, staring at the cracks on the ceiling, searching for patterns. He has never given up on a problem, he has always found some solution. He searches for patterns and decides that he should propose a new project to Scalapino, a collaboration, a physics problem that Bennett understands from the start. Nothing so grand as string theory, but something substantial. Perhaps the older physicist could spend a few minutes with him here and there. In the past, even when Scalapino worked on seemingly mundane problems, he often uncovered luminescent depths.



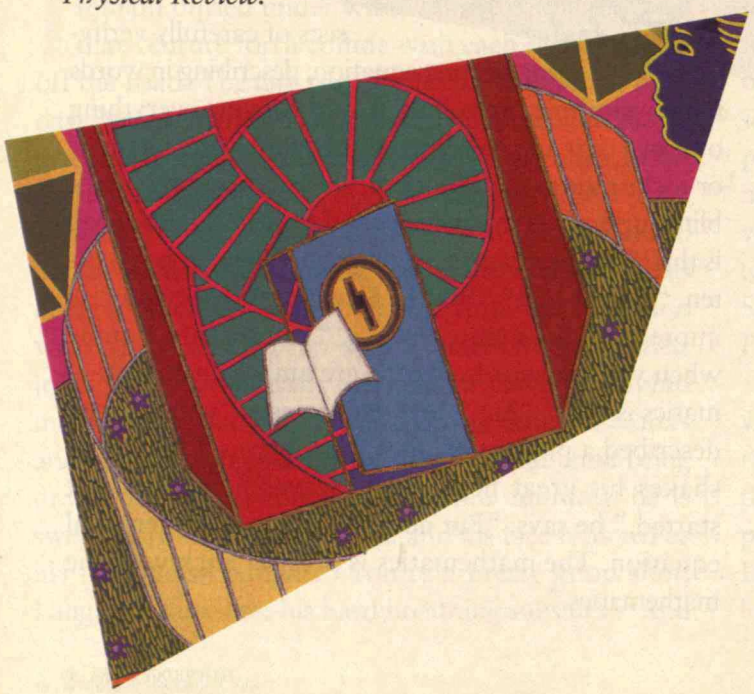
The great physicist will have to get interested. Bennett starts with his thesis work on gravitational radiation. This time, however, it is he who asks the questions. They sit in the brightly lit chess room with the computer and the random numbers. Scalapino looks up from his chess board, frowns, and returns to the game. "It's an intriguing question, don't you think," says Bennett, "the amount of free energy in a radiating system?" "Intriguing perhaps, but shallow," says Scalapino as he walks over to feed the computer his latest move. "It could, perhaps, involve the cosmic entropy problem," says Bennett. Bennett is desperately grasping at straws, but he knows that a mere mention of the entropy in the universe causes physicists to skip meals and remain glued to the blackboard for hours. No one has ever solved the problem of why the universe was created in such a high state of order. Scalapino frowns again. He stops looking at the chessboards. He seems distracted and his eyes slowly turn glassy. Then he goes to the kitchen, Bennett following behind. He paces. Without saying a word, he begins drawing pictures and bits of equations on the blackboard. He is caught.

After considerable effort, Bennett gets an explanation. Immediately, he copies everything down and hurries off to the study to add his own contribution, which consists of carefully verifying the first equation, describing in words the physical picture behind it, and copying everything over in a neat and well-documented form. After an hour or so, he returns to the kitchen, where Scalapino is scribbling furiously on his white pad of paper. "What the hell is this?" Scalapino says, reading what Bennett has written. "Take it out." "Why?" Bennett asks. "Because it's imprecise," Scalapino squeaks. "You get into trouble when you use words. Words are ambiguous. Mathematics is not." "But," Bennett protests, "you yourself described a physical picture, with waves." Scalapino shakes his great head. "The waves helped me get started," he says. "But now we've got the differential equation. The mathematics is precise. Stick with the mathematics."

At which point Scalapino effortlessly writes down more equations, which flow from his pencil like water from a spring. "What are you thinking?" Bennett asks in amazement. "Thinking?" says Scalapino. "I'm thinking that the cubic term will dominate in the near-field zone and the quadratic in the far-field. We might have to shoot to match boundary conditions."

Scalapino floats in some netherworld, half of the body and half of the mind. He can no more describe to Bennett what he is thinking than a great ballerina can say how she does a pirouette. Bennett takes Scalapino's new scribblings off to the study to purify. In an hour he returns. They repeat the process. From time to time, the house rumbles with a passing train, Sophie brings tea, Scalapino lumbers down the hall to the chess room.

The collaboration goes on in this manner for a couple of months. Bennett comes to the house several times a week. Sometimes he brings new novels for Sophie, sometimes moo shu chicken and pea pods from the Happy Palace in Fells Point. Sometimes he sleeps on a cot in the study. Occasionally he is able to go the next mathematical step without help from Scalapino, and the great physicist nods and smiles at his assistant's new result. The pages accumulate. And Bennett has managed to negotiate a small amount of text to accompany the equations, for the slow readers of the *Physical Review.*



IT SEEMS THAT ALL OF BENNETT'S LIFE FOR THE LAST HALF A YEAR HAS BEEN SQUEEZED AND DISTILLED INTO ONE LOVELY NUMBER.

It is near dawn. The three of them sprawl languidly in separate chairs, shadows in the low light of a single porcelain lamp. They sit in Sophie's reading room, full of her books. Scalapino comes here with his daughter some mornings before bed. No one has spoken for minutes. It is dead quiet. Far away, a voice floats through the walls of the house, Ella Fitzgerald singing "Do Nothing till You Hear from Me." The voice swims through the silent air, and Bennett thinks of Memphis and of Florida, his childhood nanny, singing her slow, heavy-hearted songs at the ironing board. "Who's playing the record?" he asks. Sophie shrugs her shoulders. "We don't know our neighbors," she says.

They sit half asleep, listening to the voice in the distance. Finally, Sophie stands up and stretches. "I'm going to bed," she says, yawning. She kisses her father and goes to her bedroom.

"I wish she would find a life of her own," Scalapino says quietly, after she's gone. "I've talked to her. I wish she would do something. But she won't leave me." He smiles sadly, then leans back in a pillow. In minutes, he is asleep. Bennett walks over and places the green quilt around his huge body, then walks soundlessly down the stairs.

In the middle of April, just before dawn, they finish. To solve the last equation, they've been obliged to enlist Scalapino's computer. The final result is a single number five digits long. Scalapino would have liked more digits, but his computer didn't have the accuracy.

Bennett drives slowly back to campus, watching the tops of trees start to glow in the East and the paperboys making their deliveries and the dogs stretching and waiting at the doors for their breakfasts. He is too agitated and excited to go to his apartment to sleep. So he goes to his office on campus, to the upholstered couch. Lying there, he contemplates the number, repeating it over and over. It is a beautiful number. He closes his eyes and is surprised to see the faces of Scalapino and Sophie and the kitchen with the blackboard in the corner and Scalapino waddling down the hall and Sophie's room in the dim light of dawn, and it seems that all of his life for the last

half a year has been squeezed and distilled into one lovely number. He smiles and he drifts off to sleep.

A week later, the research paper has been typed and is ready to send to the journal. Bennett sits in the octagonal reference room of the science library, checking a final notation. Looking up at a nearby shelf, he happens to glance at a recent issue of *Nuova Physica*, an obscure Italian physics journal. In its table of contents is a title similar to that of his paper with Scalapino.

His pulse races. He roughly takes the magazine off the stand, flies through the article, turning pages rapidly, and jumps to the end. The final number is the same as his to five digits.

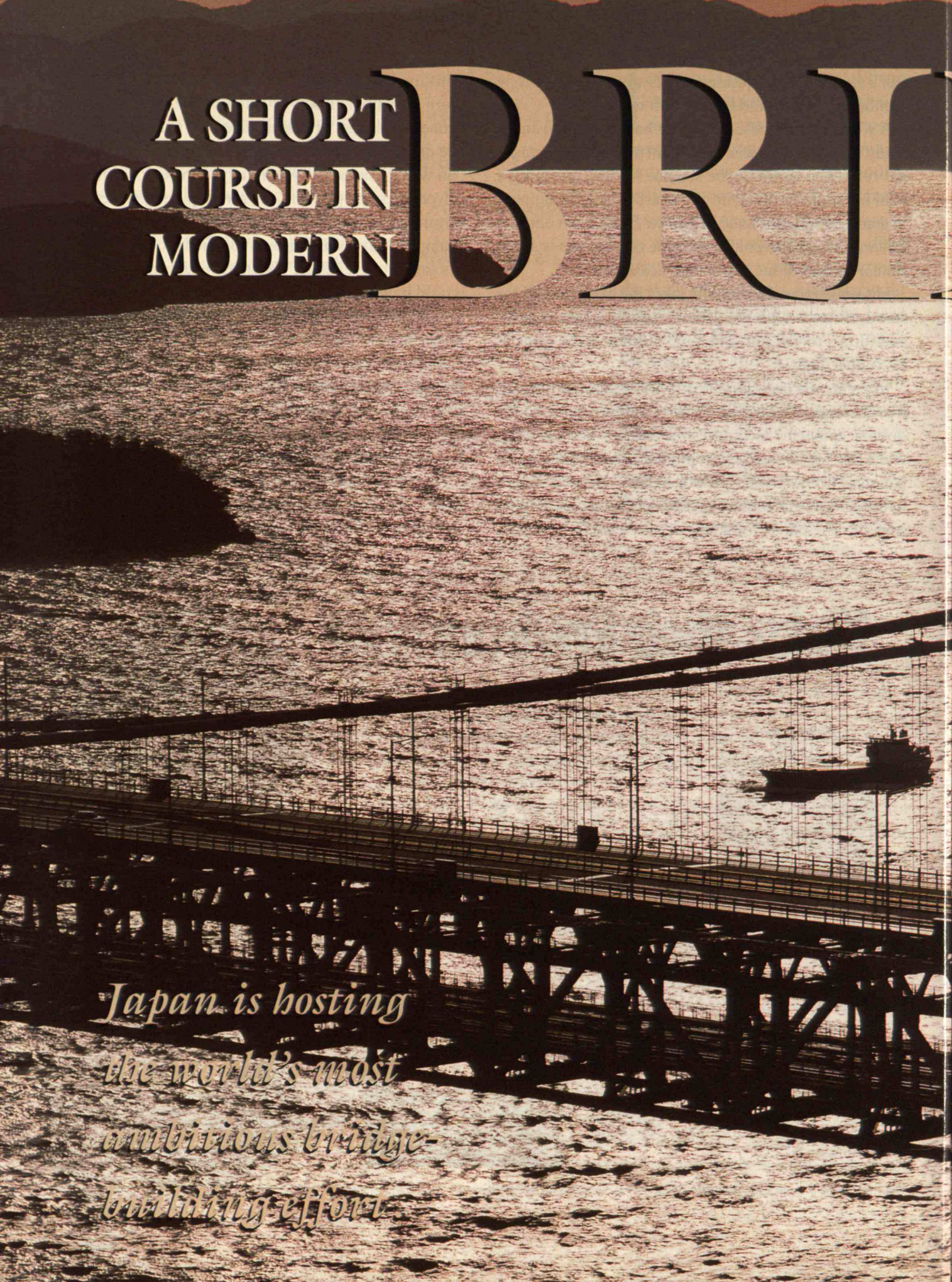
In a state of confusion, he drives to Scalapino's house. It is the middle of the afternoon. Sophie comes to the door sleepily. She recognizes his urgency and agrees to wake her father. Scalapino plods to the kitchen in his pajamas, not yet awake. "Look at this," Bennett shouts, handing him the volume of *Nuova Physica*. Scalapino stares at the paper for a few minutes, nods, and says,

"His method is clumsy. Least action is more elegant." "Look at his answer," Bennett explodes. "It's identical to ours to five digits." Scalapino shrugs his shoulders. "So what?" he says. "What did you expect? The Italian solved the same problem. It's a well-posed problem. He should get the same answer. I'm going back to bed." Scalapino yawns and moves for the hallway. "Exactly the same to five digits," Bennett repeats miserably. "It would have been seven if the 360 had more memory," says Scalapino. "Or twelve. It's a perfectly well-posed problem. Now please excuse me, I'm going to bed."

Bennett stumbles from the house. He wanders through the side streets of Fells Point for the rest of the day, finally remembers his car, and returns to his apartment, profoundly empty. Years later, he will not remember whether he ever said goodbye to Sophie.

May came and went. Bennett never heard from the dean. The dean had received an offer from Harvard and left with the first bloom of the lilacs.■

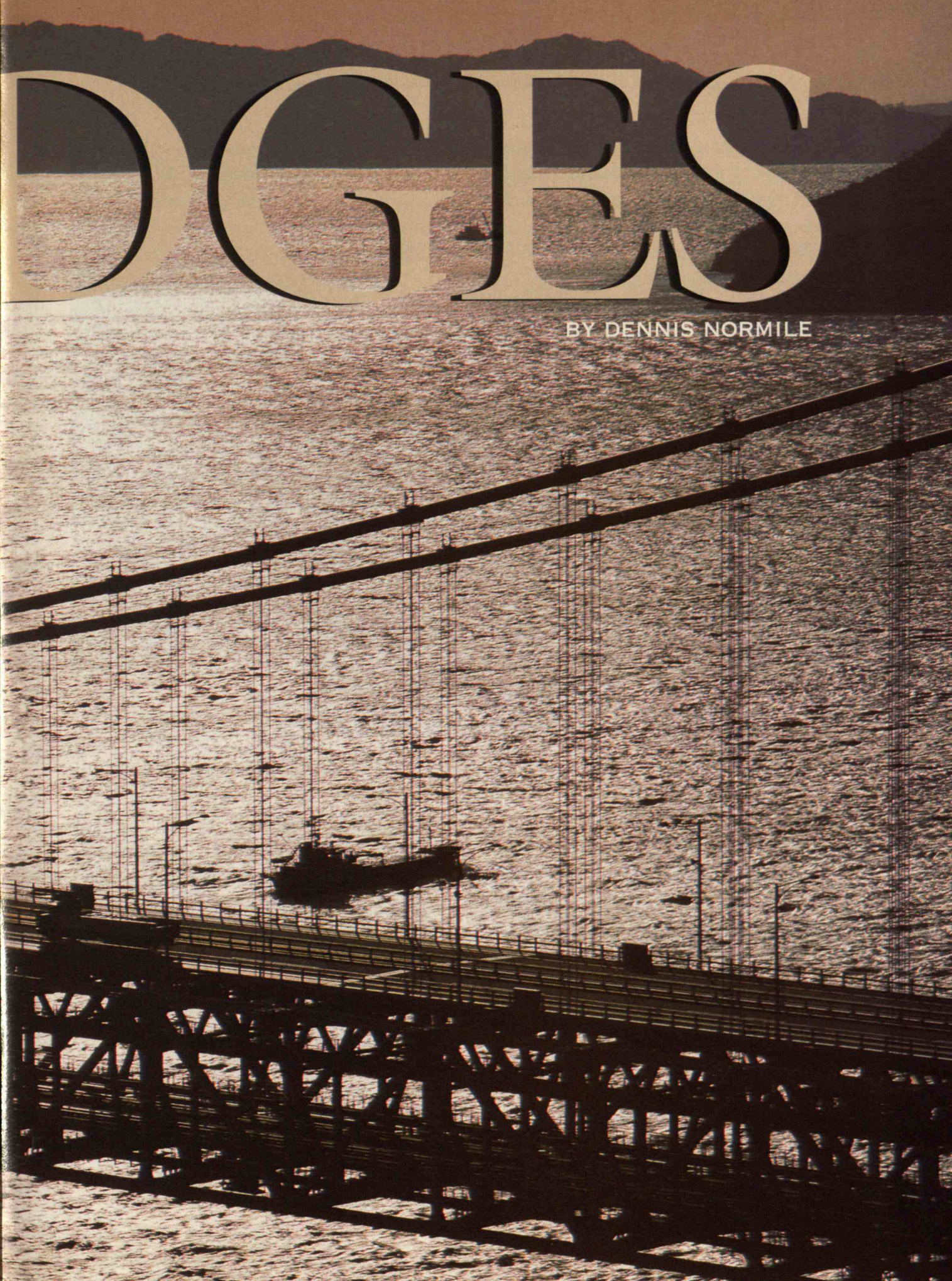
A SHORT COURSE IN MODERN BRI



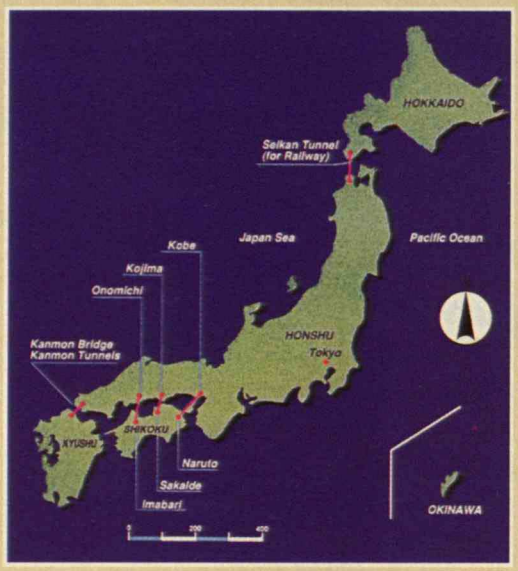
Japan is hosting the world's most ambitious bridge-building effort

DGES

BY DENNIS NORMILE



In the past, one had to traipse around most of Europe or North America to see an appreciable number of state-of-the-art bridges. A continent's worth of rivers, gorges, and inlets were required to sample the different kinds of structures in the bridge designers' bag of tricks. But by the end of this century, a course in modern bridge engineering may be fit into one day's leisurely travel around Japan's Inland Sea, where the Honshu-Shikoku bridges are being built.



Conceived as an enormous effort to bind Shikoku, the smallest and most isolated of Japan's four main islands, to Honshu, the largest and most populous, the 18 major bridges that will make up the three routes between these islands are collectively one of the most ambitious public-works projects in modern times, costing an estimated 2.99 trillion yen(about $26.9 billion using 1993 exchange rates). The routes will include some of the longest bridges in the world; one of them is likely to reign as the longest for the foreseeable future.

Saving the best for last, a tour of the three routes would start at Imabari, at the western end of Shikoku. The four-lane route to Onomichi includes the elegant arch of the Ohmishima Bridge, the first span completed. More significant is the route's next bridge, the Tatara. Two decades elapsed between the initial planning and the start of construction of this bridge, allowing for a crucial change. (Just five days before the 1973 groundbreaking of the entire project, the Japanese government halted the effort to divert resources for coping with the first oil shock. The project restarted two years later, but in a more piecemeal fashion.) Designers initially planned a suspension bridge, in which the deck is suspended from cables draped like clotheslines between two towers. For more than 100 years engineers have used suspension bridges for spanning medium to long lengths. In 1992, however, the Honshu-Shikoku Bridge Authority (HSBA) engineers decided that the Tatara crossing should be spanned by a cable-stayed bridge, in which cables fanning out from the top of the towers are attached to the bridge deck directly.

Developed 40 years ago as an economical alternative for medium-length distances (cable-stayed bridges can be erected more quickly than suspension bridges), engineers were at first cautious with this bridge type. But as designers have acquired understanding of how cable-stayed bridges behave and builders have gained experience erecting them, they have been used for ever-longer spans. HSBA engineers say such knowledge allowed them to switch to a cable-stayed Tatara Bridge.

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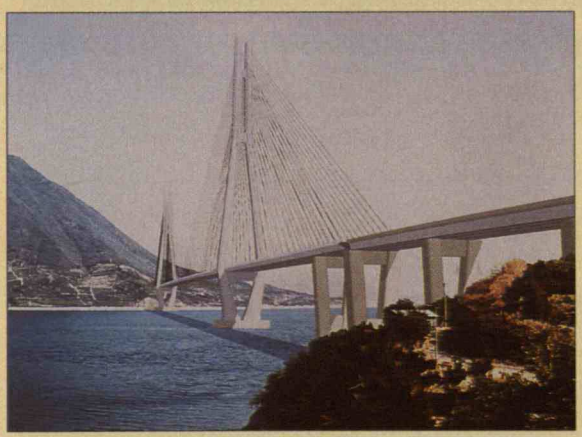
A



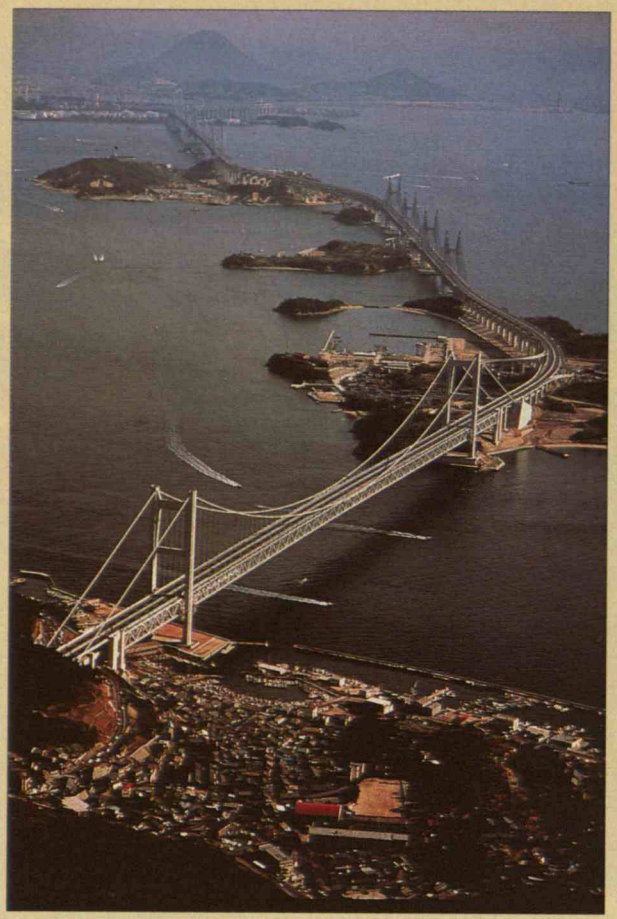
B

C

A map of Japan (opposite) shows how three routes consisting of 18 major bridges are joining the islands of Honshu and Shikoku. Above: The westernmost route, expected to be the last completed, includes the already finished, graceful Ohmishima Bridge (A). A montage (B) of a photograph overlaid with a computer-graphic image of the Tatara Bridge shows its cable-stayed design; the bridge will be the longest of its type. For another bridge on the western route (C), engineers relied on an enormous crane to support a caisson shell as it was being flooded and sunk, so that it would land softly.

PHOTOS: HONSHU SHIKOKU BRIDGE AUTHORITY AND AHMED M. ABDEL-GHAFFAR

An aerial view (D) of the Kojima-Sakaide route, the middle and first crossing completed, shows bridges flowing from island to island. Along the route, construction workers extended the deck structure of a cable-stayed bridge (E) piece by piece until the halves could be joined. The towers of the Hitsuishijima and Iwakurojima bridges (F) were designed to resemble helmets of ancient Japanese warriors. A map with Japanese characters (opposite) shows the three routes between Honshu, left, and Shikoku, right.

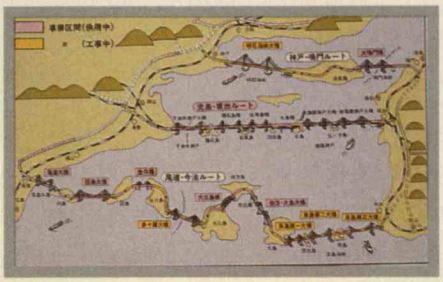


D

E

F

When completed in 1999, the bridge will be the world's longest cable-stayed crossing, with a center span of 2,920 feet, nipping ahead of the 2,808-foot length of France's Normandy Bridge and nearly double what 10 years ago many engineers considered the maximum practical length for such designs.



A particular challenge in building cable-stayed bridges is stabilizing the deck during construction to resist wind and earthquake forces. Starting at the towers, workers extend the deck structure piece by piece, supporting it vertically by the cables to the top of the towers. Before the two halves meet in the middle, they are like ever-lengthening horizontal flagpoles that wobble when the wind blows. To keep wind sway within acceptable limits, the Tatara Bridge engineers are making the deck structure so strong and stiff that the completed bridge will be unnecessarily sturdy. But they say this won't raise costs enough to ruin the bridge's economic advantage.

From the Onomichi end of the bridge a traveler would drive up the Honshu coast to the city of Kojima. Crossing back over to the town of Sakaide on Shikoku on the only route now completed would take one over a series of long suspension and cable-stayed bridges that can carry combined highway and rail traffic. The bridges' upper decks include four highway lanes, while the lower decks have two standard rail lines and are designed to support two "shinkansen" (bullet train) lines that may be added in the future.

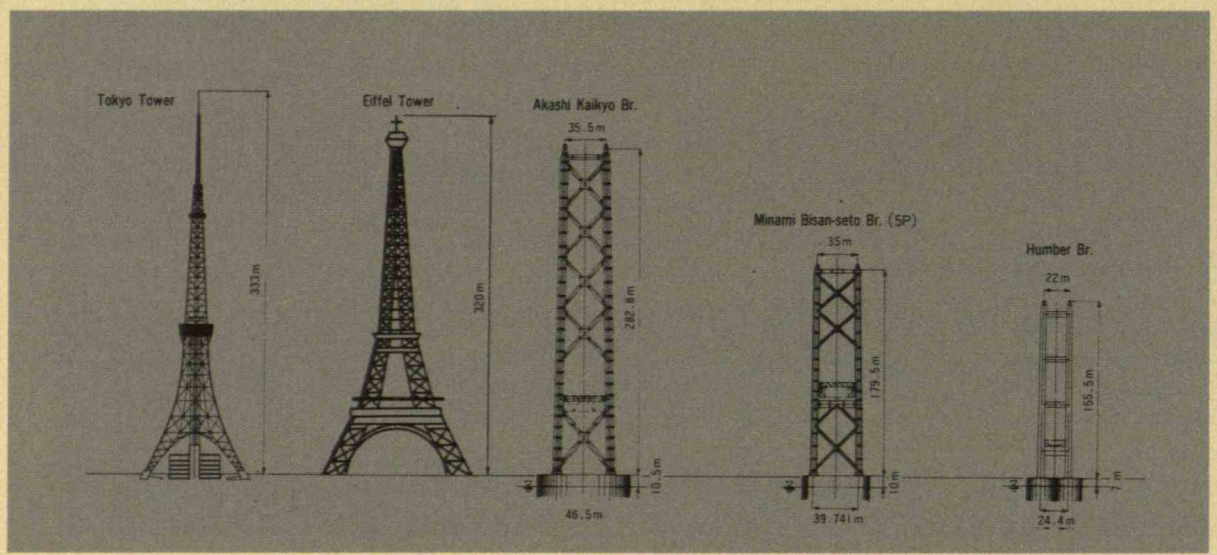
With the Kojima-Sakaide route, engineers scaled up some construction techniques planned for the third route. One involves placing bridge piers, the typically concrete columns that support the towers, in deep water. In most parts of the world, a bridge builder erects a temporary, water-tight structure extending from the sea bottom to above sea level, pumps the water out, and then builds the pier from within the structure. But for the Kojima-Sakaide route, construction workers floated steel-caisson shells the size of 15-story office buildings to their sites, positioned them using shore-based lasers, and held them in place with sea-floor anchors before sinking them onto previously prepared bearing strata. They then pumped the shells full of concrete.

With access to conveniently located shipyards, water suitable for large barges, and floating cranes with a capacity of 3,000-plus tons, the Honshu-Shikoku bridge builders have also assembled large sections of the towers and decks on the ground before barging them to their sites and lifting them into place. The most dramatic example of this "large-block erection" method, which is quicker, less expensive, and far safer than assembling a structure 200 feet or so above swiftly moving water, has been the setting of a 6,100-ton, 607-foot-long segment of the Hitsuishijima Bridge, with two mammoth floating cranes working in tandem.

Back on Shikoku, travelers would take a short drive to Naruto, then proceed to the third route over the Ohnaruto Bridge and the 37 miles of highway across Awaji Island to the Akashi Kaikyo Bridge. That bridge, which will be the world's longest, is considered the crown jewel of the Honshu-Shikoku effort.

HSBA engineers point to only a few engineering and construction techniques being used for the first time on Akashi—a newly developed high-strength galvanized wire, for example, will allow the cables to be lighter and more compact. Mostly, the engineers are stretching designs and using techniques proven on other Honshu-Shikoku bridges. The caissons will be bigger than on the Kojima-Sakaide route—each as tall as a 20-story building and almost wide enough to contain a football field. The bridge towers will be erected with more large blocks than those used for bridges on the Kojima-Sakaide route, enough to make the towers almost as tall as the Eiffel Tower (927 and 1,050 feet, respectively) and the world's tallest bridge towers. And as in some bridges along other routes, pendulum-like devices composed of heavy suspended weights that swing back and forth in opposite phase to the motion of the towers will control the towers' wind sway.

The Akashi Kaikyo's center span of 6,529 feet—longer than four Sears Towers laid out top to bottom—will leap ahead of the 4,626 feet of the United Kingdom's Humber Bridge, the current record holder, and the 5,328 feet of Denmark's Great Belt East bridge, scheduled for completion in 1997. The Akashi Kaikyo Bridge is likely to be the world's longest for some time; while engineers discuss longer bridges, such as for the strait of Gibraltar between Morocco and Spain and for the strait of Messina between Sicily and the Italian mainland, so far plans have not gone beyond talk.■



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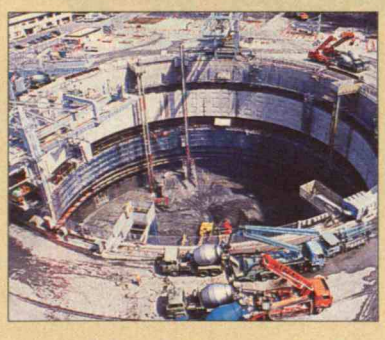

K

The towers of the Akashi Kaikyo Bridge will be nearly as tall as the Tokyo and Eiffel towers when completed (opposite). They will also be taller than today's tallest bridge towers: those of the Minami Bisan-Seto—another bridge in the Honshu-Shikoku project—and the Humber in England. A computer-graphic image overlaid on a photo (G) shows what the Akashi Kaikyo Bridge should look like. Boats tow a caisson (H) for the base of one of the bridge's towers. A helicopter pulls a "pilot rope" for the Akashi Kaikyo Bridge (I). The wire rope, the first connection strung from one anchorage to the other by way of the towers, is used to thread temporary cables that in turn are employed to string the strands forming the permanent cables. Atop one of the towers (J) rest temporary cranes used to lift miscellaneous materials during construction. The excavation pit (K) for one of the anchorage foundations for the Akashi Kaikyo bridge is almost big enough to swallow four copies of Rome's Pantheon.

Established in simpler days, the once robust and productive compact between the scientific community and the government that funds it needs an overhaul. A new agreement must reflect changes in both parties while creatively allowing for the basic differences between them.

Updating the Social Contract for Science

By David H. Guston and Kenneth Keniston

In the years following World War II, the United States established a scientific enterprise that became the envy of the world. This enterprise rested on a vision of science as an "endless frontier" that would replace the American West as the font of economic growth, rising standards of living, and social change. The institutions that supported this frontier were a distinctively American blend of public and private enterprises, eventually including an array of national laboratories, mission agencies, and even a National Science Foundation. The practices that supported it entailed what Harvard political scientist Don K. Price called a new type of federalism: the provision of financial support to scientists at public and private research universities without co-opting their independence. ❧ Research universities were the intellectual centerpiece of this enterprise, since it was there that most of the basic research was performed. At the heart of federal support for universities was the practice of competitive, peer-reviewed grants. The bargain that was struck between the federal government and university science—what is often called the "social contract for science"—can be stated concisely. On one hand, government promised to fund the basic science that peer reviewers found most worthy of support. Scientists, on the other hand, promised to ensure that the research was performed well and honestly, and to provide a steady stream of scientific discoveries that would be translated into new products, medicines, or weapons. ❧ After five decades, the social contract for science shows signs of extreme duress. Scientists and politicians have serious complaints about each other. The issues are, by now, familiar:

Illustrations By Les Kanturek

scientific fraud and dishonesty, the adequacy of science funding, indirect costs of research, administrative burdens in science, scientific priorities, big science, pork-barrel science, and so on. Reports by the congressional Office of Technology Assessment, the National Academy of Sciences, and the Carnegie Commission on Science, Technology, and Government have analyzed what some perceive as a "crisis" in science policy.

Despite this scrutiny, the underlying causes of today's conflicts in science policy remain obscure. We do not believe that the antagonism between science and politics signals either a new or a terminal crisis. But today's struggles do indicate that the old contract between science and government needs updating; they also point to enduring and irreducible tensions between the principles of science and those of democratic government.

Changed Government

Although scientists sometimes lament the passing of a golden age of government support for science, the history of postwar science policy fails to reveal a truly privileged past. Throughout the last 50 years, controversies between the political and the scientific communities have always been present—over the loyalty of scientists and the merits of military research, over financial accounting for grants, over applied versus basic research, over payment for the indirect costs of research, and above all, over how much money Washington should dedicate to scientific research.

The pattern of federal funding for research and development also belies any image of a lost golden age. Those who pine for the good old days usually recall the mid-1960s, when federal R&D spending reached an all-time high, whether measured as a percentage of the gross national product (in which case 1964 was the maximum) or as a share of total federal spending (in which case the peak came in 1965). But measured in constant dollars, the situation is less clear. By the Office of Management and Budget's method of discounting for inflation, the peak of real federal spending was 1966 or 1967. By the National Science Foundation's method, R&D spending in 1990 was about 30 percent *higher* than the supposed 1966 peak.

In any event, the mid-60s spending levels are a problematic reference point, because federal spending for science and technology in those years was inflated by competition with the Soviets and by the Apollo program. From 1963 to 1972, defense R&D accounted for almost 54 percent of federal expenditures in science and technology. The Reagan defense buildup raised average defense R&D spending between 1983 and 1992 to about 56 percent of total federal R&D. But the average defense share has since fallen to less than 53 percent, and President Clinton has promised to reduce the defense share to 50 percent. Furthermore, space-related R&D, which accounted for 27 percent of federal expenditures between 1963 and 1972, accounted for only 7 percent between 1983 and 1992.

Another way to look at R&D spending is to compare it with the rest of the federal budget. Over the last decade the share of R&D in the domestic discretionary budget has risen, while almost all other items have fallen. That is, through the 1980s, R&D consumed a growing share of the shrinking pie of nondefense, nonentitlement spending. For this reason, calls for greatly increased science budgets are ill-starred from the beginning. The sufferings of scientists may be real, but in the words of Rep. George Brown (D-Calif.), one of the strongest patrons of science, they are not unique.

It nevertheless remains true that irreversible changes have occurred in the last five decades. Indeed, perhaps the simplest explanation for the heightening of tensions between government and science is that the original contract was made between a kind of government that no longer exists and a kind of scientific community that has long since disappeared.

In the postwar years, both the executive and legislative branches have changed in ways that affect the support of science. At the executive level, the "imperial presidency" has extended the chief executive's prerogatives far beyond their prewar limits, and the "management presidency," centered in the Office of Management and Budget, has emphasized control of the sprawling bureaucracy. The White House has added analytical capabilities: the special assistant to the president for science and technology, and the president's Science Advisory Committee. More recently, scientific advisory committees have proliferated in other departments and agencies. The executive branch increasingly tries to coordinate federal R&D in the various agencies, the most recent mechanism being the National Science and Technology Council, composed of Cabinet chiefs and the heads of independent agencies and chaired by the president.

In Congress, the power of committee chairs has declined through the postwar years and has been replaced by a radically decentralized organization, with participation from subcommittees as well as action outside of committees. There has been a resurgence of congressional oversight directed at maintaining accountability over burgeoning programs and

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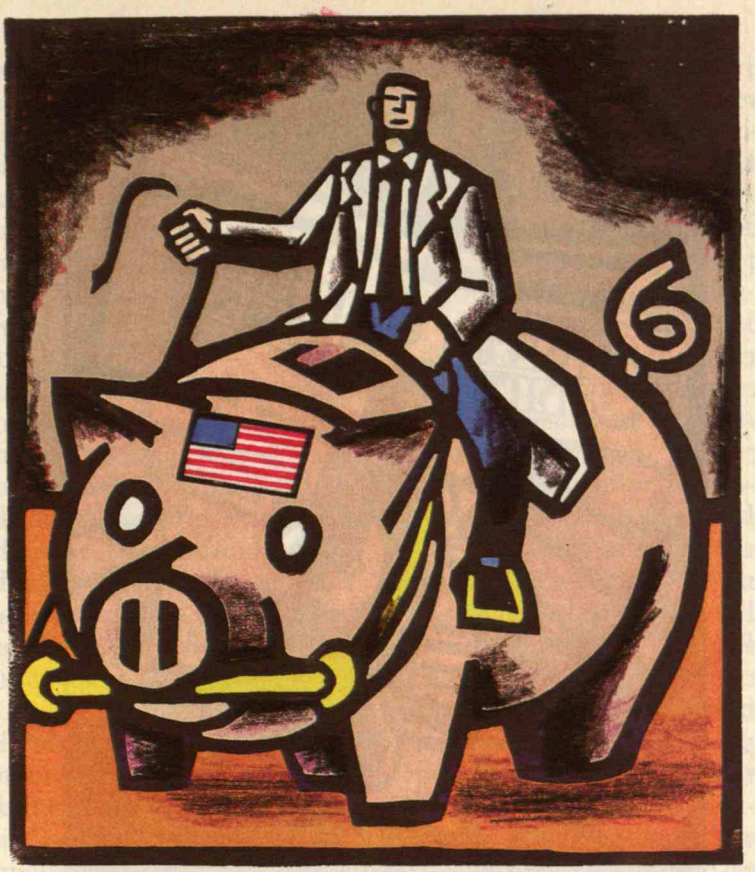
agencies. In the early 1970s, Congress augmented its analytical capabilities by creating the Office of Technology Assessment and the Congressional Budget Office, expanding the Congressional Research Service, and increasing control over the General Accounting Office. Committee and personal staffs have increased in size and professional competence. Congress has also created an Office of Inspector General in each major department and agency to monitor the implementation of policy.

Such changes—even if not intentionally related to science—have given both the executive and the legislative branch greater motivation and competence to evaluate and oversee the scientific community.



To preserve the principle of federalism, universities and their researchers—not Washington—should maintain primary responsibility for managing scientific work.

Changed Science

If government has been transformed in the last five decades, so has science. The scientific enterprise has grown vastly in workforce, complexity, and size of projects, and it has therefore grown more expensive to fund. For example, the scientific workforce nearly doubled between 1965 and 1988, from 495,000 to about 950,000. And the proportion of the nation's workforce who are scientists and engineers engaged in R&D rose from its previous high of 67.9 per 10,000 in 1968 to 75.9 per 10,000 in 1987.

Federal funding of research has always sought to turn out more PhDs so as to provide the nation with a highly trained scientific workforce. But however commendable this goal, it has a bizarre consequence: the more successful the program is, the greater will be the future demand for research financing. It is rather as if a welfare program created a half-dozen new welfare applicants for every one who is given federal assistance. This steady increase in the number of scientists means that despite real growth in R&D funding, a smaller percentage of applications for grants can be funded each year. The scarcity of research funds felt by the scientific community is quite genuine on a per capita basis.

The size and complexity of scientific projects have also increased greatly. The Manhattan Project and other wartime endeavors inaugurated a trend toward "megascience." Research projects today involve more people and require more expensive equipment than ever before. Science has become a vastly more complex aggregate of new technologies and advanced education. As a result, the price of research has gone up much faster than inflation. For this reason, too, scarcity is felt even in the midst of generous funding.

Meanwhile, popular support for science has waned. The almost unqualified public enthusiasm that characterized the immediate postwar period has given way to a far more nuanced view of science and technology. Attitudes have been negatively influenced by conspicuous technological failures—Chernobyl, Bhopal, *Challenger*—which raise concerns about science by the reverse application of the logic that predicts technological benefits from scientific triumphs. It was President Eisenhower who appointed the first special assistant to the president for science and technology. But it was also Eisenhower who warned the American public in his farewell address that "public policy could itself become the captive of a scientific-technological elite." The apprehension of such an elite found expression through many voices: social critics like Theodore Roszak, environ-

mental activists like Rachel Carson, and antimilitary movements that blossomed on the campuses of research universities.

Of all the changes since the postwar negotiation of the social contract for science, the end of the Cold War is probably the most consequential. Ever since 1945, the promise of military applications and the specter of Soviet competition has driven federal R&D expenditures in both military and civilian agencies. The expected usefulness of science and technology to the conduct of the Cold War—both in material terms of building effective weapons and in symbolic terms of conquering the new frontiers of space, the atom, and the cell—meant that governments and publics (in the former Soviet Union and the United States alike) viewed science in a favorable light. But today, without an implacable communist foe, the instrumental value of science and technology has lost some of its urgency.

The result, especially for the physical sciences, is that a new rationale for public support is needed. Previously, the goal upon which almost everyone agreed was countering the Soviet threat. Today, other goals for science are alleged—or, more precisely, revived. For the founders of the American system of science funding, the military rationale was only one among many, including human betterment through fuller employment, a rising standard of living, and better health. The health claim has never lost its persuasiveness, but the rationales of employment and living standards are now being resurrected and redefined.

This redefinition sometimes involves a claim that science-based innovation is the elixir that will stimulate the nation's economy and improve its international economic competitiveness. According to this argument, such innovation has produced entire new industries—consider the transistor and genetic engineering—and will give the United States a technological advantage in competing with other nations for markets and high-wage jobs. In its simplest form, the argument posits a direct causal link between the advances of science, success in the international marketplace, and a rising standard of living.

The old contract between government and science was fragile because it attempted to keep politics and science as separate as possible.

In this simple version, the argument is open to an obvious criticism: the United States is unquestionably the world's leading scientific power, but it lags by international standards in health, has fallen behind in productivity gains, and is being overtaken in standard of living and international trade. More sophisticated versions of the theory therefore argue that good science is a necessary but not sufficient condition for productivity. A primary point of this more subtle formulation maintains that the postwar research system, even though highly successful so far, has become less effective in today's environment because it was geared toward a different set of military, political, technological, and economic challenges.

Even this cursory analysis of changes in the last five decades suggests that the current strains in government-science relations were inevitable and necessary. Government has increased in size, complexity, competence, and capacity both to support and to oversee science. Science, too, has grown and now faces the consequences of its maturity. The old military rationale for public support has lost much of its cogency, and

science faces a more critical public than it did 50 years ago. The old contract was written in simpler days. It has become more fragile today partly because the two parties that agreed to it have changed.

The contract clearly must be updated. But it must also confront the basic tensions between science and democracy.

Science versus Democracy

Imagine members of Congress commissioning a National Academy of Sciences report on the organization of science-funding agencies, then gathering testimony from scientists on priorities in science funding, the role of different sectors and institutions in the scientific enterprise, the tension between centralization and pluralism in research, the merits of large-scale versus small-scale projects, and the financial accountability of researchers. Is this Rep. Brown's recent Task Force on the Health of Research? Rep. John Dingell's Subcommittee on Oversight and Investigations? Rep. Don Fuqua's Science Policy Task Force of the mid-1980s? The Fountain Committee, the Elliot Committee, or the Daddario Subcommittee of the 1960s?

Actually, it is the Allison Commission of the 1880s, a select congressional committee that examined all these questions with regard to the federal scientific establishment. Like some dysfunctional family, the science policy community in the United States seems to confront the same problems, never finally resolving them even over many years. Why do the same problems constantly arise? Why is it that no institutional arrangements seem capable of eliminating the tensions between government and science?

One can find only a partial answer in the complaints that scientists and politicians make about each other. Politicians are charged with a lack of knowledge and appreciation of the scientific enterprise; scientists, with arrogance, elitism, and political naïveté. But the dysfunction exists not simply because politicians can be ignorant or scientists arrogant. The deeper reason lies in fundamental and ineradicable differences between the organizing principles of a democratic polity and the organizing principles of the scientific community.

There are three fundamental tensions that make for an uneasy relation between government and science. The first is simply that popular tastes and preferences are different from, and sometimes antagonistic toward, those of the scientific community. One might call this the populist tension, and it can result in popular pressure for a more equitable geographic distribution of research funds, for more applied research, for a particular focus of programmatic research such as women's health, or for a greater emphasis on teaching and patenting than on research itself.

Scientists rightly ask whether public opinion should matter in science, because popular pressures could seriously reduce the long-term viability of the scientific enterprise, and at times can reflect "anti-scientific" attitudes. But in a democratic society, citizens must be allowed to choose between the viability of science and the viability of other valued enterprises. Even though science is the pursuit of the truth, it is still only one pursuit among many that citizens value. What the populist tension really does is force the advocates of scientific research to articulate a publicly compelling rationale for their activities and then, like any beneficiary of public funds, to be accountable for the outcomes.

The second tension derives from the fact that the economic organization necessary for science to flourish may be at odds with the economic organization necessary for democracy to flourish. One might call it the plutocratic tension, because of the importance of wealth in determining the distribution of scientific resources. This tension is obvious in political concerns about the concentration of R&D funding at a small number of major research universities, as well as worries about the real growth of the R&D budget when most other domestic programs are contracting. It is also evident in concern over the growing fuzziness between public and private interests, as public employees and private firms benefit financially from the fruits of publicly funded research. Another expression of this tension is the fear that the benefits of science-based technology—from the profits yielded by new drugs to the conveniences of consumer technologies—more often accrue to the haves of society than to the have-nots. The basic question behind the plutocratic tension is whether science, because it is relatively rich and privileged, will become richer and more privileged still, and will mostly benefit the non-scientists who are already rich and privileged.

The third tension between democratic politics and scientific practice arises from the fact that democratic processes and goals are largely incompatible with scientific processes and goals. One might call this the exclusionary tension, because the requirements for membership in decision making within science are more exclusive—that is, being a scientist or an expert—than for membership in democratic decision making in general. Democratic decision making constantly seeks to encourage and expand participation; scientific decision making limits it. There is a risk that science may oppose democratic decisions that deviate from or deny some scientifically defined truth. But as political theorist Robert Dahl has written about the idea of allowing experts to guard democracy against incorrect decisions, scientific guardianship, if carried to an extreme, is simply a prettier name for dictatorship.

The tensions between democracy and science boil down to conflicting values: democratic politics cherishes participation and the pursuit of justice; science cherishes

inquiry and the pursuit of truth. Because the gap between participation and truth can never be closed, the tensions will always exist.

Any two parties with different goals and structures require a carefully wrought contractual relation if they are to collaborate productively. It therefore follows that something like a social contract for science continues to be necessary. It follows, too, that this contract should give explicit attention to the details of the interaction between government and science, or, more precisely, between the public and scientists. An attempt to run science on democratic principles would destroy science; but that does not mean that the existing institutions and processes of science are democratic enough. An attempt to run government on scientific principles would destroy democracy; but similarly, that does not mean that our current politics is sufficiently informed by scientific knowledge. Only by deliberately designing institutions and processes that confront the inevitable tensions between democratic government and scientific practice can these tensions be minimized.

The old contract between government and science was fragile because it denied these tensions, attempting to keep politics and science as separate as possible. Such a contract has indeed outlived its usefulness. The new contract as it evolves must take into account the blurred boundaries between politics and science, all the while recognizing that the differences between them are intrinsic.

The Future of the Contract

Scientists and politicians must be willing to concede to the other some role in each other's enterprise. The scientific community, in particular, must confront directly the fact that it is in competition for federal funding with other meritorious projects. Like it or not, if science expects public support, it moves into an arena where it must be political—in the best sense, and possibly the worst—in order to justify its claim to public support.

By being political, we do not simply mean joining the horde of lobbyists competing on behalf of clients for public boons—although in the United States, lobbying is a time-honored and appropriate activity. More than that, we mean recognizing and responding to the ways in which science and its support are embedded in public attitudes and public policy.

The scientific community and the research universities in which this community is rooted must undertake an educational role with a dual purpose: first, to make clear the nature and workings of science; and second, to bring to the greater community those scientific insights, findings, theories, outlooks, and facts that can indeed contribute to the public good.

In both regards, university science has only begun to explore its role. Academic scientists need to participate more actively in broadly educational activities such as training science and technology journalists, along with focused pedagogic activities like collaborating with educators in primary and secondary schools to improve scientific literacy.

Given that American science must compete with other good purposes and institutions for the favorable opinion and support of a democratic government, and given that the Cold War has ended, the future relationship between science and government depends heavily on the capacity of the scientific community to articulate a plausible rationale for public support and to demonstrate that rationale at every turn. As military preparedness yields to international economic competitiveness and domestic well-being on the list of national priorities, support for science will depend on the scientific community's willingness and capacity to help resolve economic and domestic problems.

What this requires is a program of vigorous outreach to the public, to public administrators, to leaders of the private sector, and to lawmakers. If academic science indeed has a contribution to make, it is no longer enough—if it ever was—for scientists to wait in their laboratories for the telephone to ring. More enterprising and collaborative projects are necessary. This change will be difficult for scientists whose talents lie in the laboratory rather than in public speaking. But there are others who are gifted teachers and interlocutors, and whose enthusiasm for science impels them to share its beauty and its relevance with others. The scientific community must treasure such individuals or risk undercutting public support for science.

At our own institution, we think of the Leaders in Manufacturing Program, an alliance of MIT faculty with several major U.S. corporations, aimed at training a cohort of corporate leaders versed in the latest manufacturing technologies and management strategies. In the same vein is the creation of workshops for congressional staff members on science and technology. At a more general level, MIT's Knight Science Journalism Fellowship Program has expanded the knowledge of more than 100 leading science and technology journalists and media experts over the last 10 years.

The scientific community must initiate more activities like these: projects that move beyond lobbying to outreach and education, activities that constitute a series of "mini-contracts" between the needs of particular constituencies and the capacities of the scientific community to respond to those needs. It is not enough for the scientific community simply to claim that it is useful; the relevance of scientific knowledge and perspectives to the public interest must be demonstrated again and again in concrete projects.

Government, too, will require new strategies and per-

haps new institutions if the contract with science is to be successfully renegotiated. One urgent and oft-noted need is for a more rational way to determine the level of overall federal spending for R&D and the priorities within those expenditures. Too often, public financing of science and technology is based on the political power of a particular disease lobby, the eagerness of members of Congress to earmark scientific and technological projects for their home districts, or intensive lobbying by a group of scientists for their own specialty. Needed instead is an orderly, open, and publicly accessible process. In this regard, the recently established White House National Science and Technology Council (NSTC) promises to be instrumental in drafting an overall R&D budget and in setting priorities within the budget. This body continues to rely on the tried-and-true process of peer review for evaluating individual projects.

What the NSTC needs is a reasonable and articulate strategy for choosing among projects and disciplines. Such a strategy might include giving priority to important disciplines in which the United States compares unfavorably with other nations (as a recent report of the National Academy of Sciences suggests) and inviting consumers of research in industry, education, health, and other fields to assess the output of federal research funding.

At the same time, however, the combination of political priority setting and scientific peer review must not shut out public input. Precisely because research is difficult and performing it can require many years of training, the temptation to confuse the performance of scientific research with the making of science policy is great. The making of science policy by the federal government, or for that matter by state and local governments, needs to be open and democratic. We have urged scientists to reach out to the public to explain what they do and to help ensure that their work is put to good use. This outreach goes for naught if the public is excluded from decision making about science. In this regard, public input, and not just expert advice, is essential at all levels of science policymaking. A "national forum" on science and technology priorities, such as that recently proposed by the Carnegie Commission on Science, Technology, and Government, could help provide such public input if properly constituted. Millions of Americans, not themselves scientists, have strong and legitimate opinions about the value to them and to the nation of space travel, local technology-development centers, and cancer research, among other scientific and technological projects. Their participation should be welcomed and respected.

Now that the Cold War has ended, continued support for science will require a program of vigorous outreach to the public.

A third major obligation of government is to preserve R&D as an example of the sturdy American principle of federalism—that decisions should be made and actions taken at the most local level possible. In science policy, this means resisting the temptation to micromanage scientific work, and the researchers and institutions that conduct it, from the distance of Washington. To be sure, government needs to establish standards: it may rightly impose exacting ethical and financial requirements upon researchers who receive public monies. But the only way to implement such requirements consistent with the federalism that inspired the social contract for science is to insist that universities and their researchers maintain primary responsibility. For exam-

ple, an incentive system for dealing with indirect costs—in which the government sets the overall rate and universities can pocket the remainder if they come in under that rate—may be preferable on grounds of both principle and efficiency to either the preexisting system of making a separate agreement with each university, or any more invasive system in which government accountants would formulate budgets for overhead.

In science policy, as in other areas of governance, a primary responsibility of public officials is to preserve as many independent centers of initiative and locally governed activities as is consistent with the broad rules of accountability and fairness. In the long run, science and technology flourish when multiple independent centers of activity are encouraged; they fail to thrive under the heavy hand of centralized control and unified direction. This is just as it should be in a federal republic like the United States.

Millions of Americans have strong and legitimate opinions about the value to them of scientific projects. Their participation should be welcomed.

These amendments in the social contract for science will never resolve some of the tensions inherent between science and government. But in recognizing the tensions, the changes can make for a more robust and productive relationship. The American system of science and technology has been outstanding in the last half-century in good part because public policy was designed to foster a plurality of centers of scientific and technical excellence with the maximum possible autonomy and responsibility delegated to each local center. No better principle than federalism can be imagined for the new social contract for science. ■

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ROSS E. MITCHELL AND JUDITH WAGNER DECEW

Dynamic Negotiation in the Privacy Wars

New telecommunications technologies are undermining our ability to remain anonymous. The situation has inspired a sensible solution that would make privacy self-regulating.

PEOPLE want information about others but are reticent to divulge it about themselves. Nowhere is this conflict more apparent than in the telephone feature known as caller identification, or caller ID, which allows those receiving calls to see the telephone number and name of the caller before answering the phone.

Telephone companies are promoting and installing caller ID throughout the country. Proponents of the technology argue that it provides a valuable service to those pestered by obscene or harassing phone calls or persistent telemarketing. But some privacy advocates vehemently disagree, maintaining that callers should be able to choose to remain anonymous. In a world of interlinked computer networks and massive data banks, they say, people already give away too much personal information without their knowledge and consent. They further worry that the prospect of identification will deter anonymous police tipsters and callers to hot lines for drug abusers, AIDS victims, or runaways.

There is, however, a logical and intuitive way to implement this technology that should satisfy both camps. This new way of thinking about privacy regulation, which we call "dynamic negotiation," permits us to enjoy the benefits of new telecommunications technologies—including, but not limited to, caller ID—without sacrificing our right to privacy.

Most caller ID systems automatically release the caller's phone number. To prevent this information from being divulged for a particular call, the caller must enter a code (typically *67) before dialing the number. In other words, callers must take an extra step to retain the privacy that they had taken for granted. They must learn how to block transmission of the data, and must remember to dial the code each time. This is known as "per-call" blocking.

Some phone systems allow "per-line" blocking—the caller's number is kept private by default and is released only when the caller enters an "unblocking" code. But in rules scheduled to take effect next April, the Federal Communications Commission has decided that the potential public value of caller ID outweighs the privacy concerns of those who want automatic blocking of numbers. The commission stated that per-line blocking was "unduly burdensome" and ruled that on interstate calls, only per-call blocking is to be permitted—preempting state regulations that allow per-line blocking.

We propose an alternative—a system that allows people to dynamically negotiate the degree of privacy they wish to sacrifice or maintain.

Here's how such a system would work with caller ID. Initially, all phone subscribers' lines would, by default, block the release of the caller's number. Subscribers could choose to release their number on a per-call basis by dialing an unblocking code (other than *67). So far, this is just per-line blocking. But in the system we suggest, phones with caller ID displays can also be set up to automatically refuse calls when the number has not been provided by the caller. When an anonymous call is attempted, the phone doesn't ring. The thwarted caller hears a short recorded message that to complete the call, the originating

ILLUSTRATION: SUSAN LEVAN

phone number must be furnished. This message then instructs the caller what code to dial to give out the number. Otherwise, the call is incomplete and the caller is not charged. Thus, a caller has the chance to decide whether a call is important enough that it is worth surrendering anonymity.

This solution preserves choice and ensures privacy. Callers can control, through a dynamic and interactive process, when to give out their numbers; recipients can refuse anonymous calls.

Most callers, of course, will want to release their number when calling friends and associates. And if such calls dominate their use of the phone, they might choose to change the default on their line so that it automatically releases their number unless they dial in a blocking code. Thus, a dynamic negotiation system may well lead many people to change from per-line to per-call blocking—precisely what the phone companies and the FCC favor. But when these customers change their default setting, they will know what they are choosing and why; they will be actively consenting to give out their numbers as a matter of course.

Most businesses will want to take all calls, whether numbers are provided or not. But certain establishments might want to reject anonymous calls—for example, pizzerias that want incoming numbers for verification to avoid bogus orders. Most callers will happily unblock their numbers when such a business asks them to.

Some display units that can be purchased for use with caller ID are already able to reject anonymous calls, but they are a far cry from the dynamic negotiation system that we propose. With these caller ID units, every call, whether accepted or not, is considered to have been answered—and charged to the caller. But a call that is rejected because of its anonymity should entail no charge. This requires that the call be intercepted by the phone company's central office switchboard before it reaches the recipient's line.

Although inspired by the debate over caller ID, the concept of dynamic negotiation of privacy can apply to other telecommunications technologies. One likely candidate is electronic mail. With traditional paper mail, people have always had the right—and the ability—to send anonymous correspondence. Delivery of the envelope requires neither that a letter is signed nor that a return address is provided. On the receiving end, people have the right to discard anonymous mail unopened.

Applying the principles of dynamic negotiation, senders of electronic mail would have the option to identify or not identify themselves. Recipients could reject as undeliverable any e-mail with an unidentified sender. The sender would then have the option to retransmit the message—this time with a return address. As with caller ID, the users negotiate among themselves. The system itself remains privacy neutral.

Several criteria guide such an approach: the need to protect individual privacy for all parties to a communication, the importance of letting new technologies flourish, and the need for national guidelines to provide consistency in system use and privacy protection. Since technological innovation proceeds rapidly, we must continually examine how best to make possible new features while preserving or enhancing our existing level of privacy.

The technology for implementing dynamic negotiation is already available. All that is needed is for the FCC to amend its recent ruling. If the FCC refuses, the House Telecommunications Subcommittee should propose legislation to require dynamic negotiation. With this system as the national norm, privacy concerns would become self-regulating. ■

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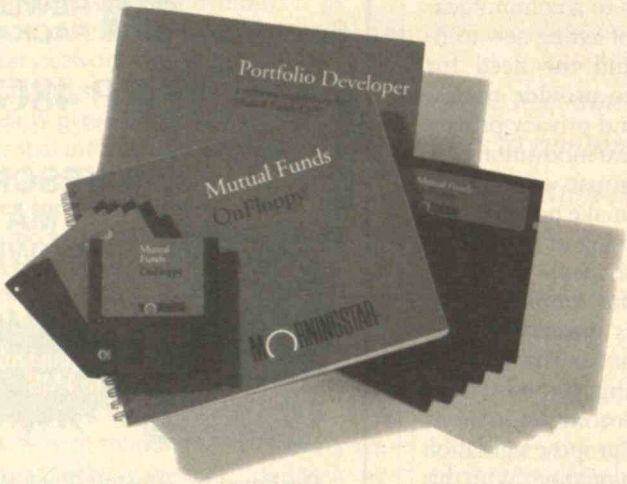

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MORNINGSTAR

A Potent Global Agency for Science

THE effort of the United States to elicit international collaboration on the superconducting supercollider (SSC) was unsuccessful, at least partly because there was no established mechanism through which government science and engineering ministers could convene to thrash out goals, responsibilities, and funding early in the project's conception. The giant particle accelerator was ultimately aborted—the U.S. Congress was not willing to undertake such a large project alone. Japan encountered similar reluctance when it tried to convince other governments to join in that country's Intelligent Manufacturing Systems initiative.

Different outcomes might have resulted had there existed a World Science Organization (WSO)—a treaty-level organization providing a forum for government science and engineering leaders to discuss and formulate international programs and commit resources. A WSO could advance the involvement of the international science community in action on global problems—such as biodiversity and sustainable development—which existing intergovernmental bodies do not adequately address. WSO could also be an international home for such global efforts as the study of the human genome and research on fusion energy. The organization could help establish ways for all nations to share the data riches emanating from new earth-monitoring systems. Finally, it could be an intergovernmental mechanism for building scientific and technological capacity in developing nations.

There is, of course, already an alphabet soup of international organizations, many of which have some scientific responsibility. But the various specialized UN agencies with some technical role—such as the World Meteorological Organization (WMO), the United Nations Environment Program (UNEP), the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the International Telecommunications Union (ITU)—focus on special fields of science, usually related to operating and regulatory functions. WMO, for example, funds atmospheric science principally to support the work of operating weather services. Similarly, the FAO sponsors agricultural science with the aim of improving world agricultural practices.

One might think that the United Nations Educational, Scientific, and Cultural Organization (UNESCO) could serve as a World Science Organization. But representation in UNESCO programs is by lower-ranking specialists who have neither a broad overview of their governments' scientific policies nor the ability to influence budgets. UNESCO is frequently torn by political, economic, and cultural controversy that cannot be resolved at lower echelons.

Indeed, most international science endeavors that have succeeded have drawn heavily on the nongovernmental scientific community. Such projects include the National Science Foundation's Deep Sea Drilling Program, which has revolutionized our understanding of the dynamics of the solid earth, and the Global Atmospheric Research Program (GARP), which extended the time range of weather forecasting.

The principal nongovernmental vehicle for collaboration among the world's scientists has been the International Council of Scientific Unions (ICSU). ICSU has from time to time joined with intergovernmental bodies in joint efforts. It collaborated with WMO in the planning and conduct of GARP and continues to work with WMO and UNEP on the World Climate Program. Most recently, ICSU has been an adviser to the United Nations Conference on Environment and Development, which organized the 1992 Earth Summit in Rio de Janeiro. But because of financial weakness and thin staffing, ICSU has only infrequently been called upon by intergovernmental organizations.

A nucleus of a WSO might be established by breaking out the scientific activities of UNESCO, with each nation represented by its minister of science rather than by a lower-level technical specialist. The ICSU could formally serve the WSO as an advisory group, similar to the way the National Academies of Sciences and Engineering advise the U.S. government. Funding from the WSO would strengthen ICSU financially—and the intellectual power of the global scientific community would complement the political power and influence wielded by the world's science ministers.

The establishment of a WSO, whether in the UN system or separately, will meet resistance. Governments dislike new institutions, with their costs and bureaucracies. Existing international agencies such as UNESCO will oppose the separation of science from its purview. Nevertheless, it is time that science and engineering, with their applications so central to the future welfare of humanity, establish a strong and independent voice in the firmament of intergovernmental organizations. ■

ROBERT M. WHITE, a meteorologist, is president of the National Academy of Engineering.

PHOTO: CLAUDE VAZQUEZ

Kill the Whales?

STROLLING through a lovely sculpture garden in the middle of Oslo a couple of years ago, I smelled steaks sizzling on a grill. "Would you like some?" asked the man behind the barbecue.

"What is it?" I replied.

"*Hval*!" he exclaimed. Whale.

Such was my jarring introduction to Norway's decision to renew the practice of commercial whaling, defying an international moratorium. So far, the Norwegians are hunting only the minke whale—a small baleen species that migrates through the North Sea. Since 1993, they have "harvested" more than 300 minkes for domestic consumption, along with several dozen others taken for research.

Like many Americans, I see whales as peaceful, intelligent, sensitive, and highly sociable creatures that pose no threat to us and that deserve protection in their native habitats. Recent books, movies, and television documentaries reinforce the conclusion that whales are capable of language and that some species "sing" elaborate rhapsodies. From this viewpoint, their well-being is emblematic of humanity's steps to achieve a new level of responsible stewardship over the biosphere.

To my shock, however, none of my Norwegian friends and colleagues share these convictions. Norwegians, even the most politically progressive, are simply not won over to the American view that whales are exalted creatures. People whom I deeply respect—philosophers, scientists, political activists, postmodern feminists, even radical environmentalists in the "deep ecology" movement—all told me essentially the same thing. Hunting whales is a traditional part of the country's seafaring economy, they said, and whale meat was once a dietary staple. Whales, they argued, are just cows that roll in the surf, and hunting them is no more immoral than hunting deer or elk.

Perhaps the cultural difference is not so surprising. After all, until recently we Americans held views about whales almost opposite from ones popular today. The books and movies I enjoyed as a child portrayed whales as dangerous sea monsters that sailors had to harpoon before they smashed their ships to bits. It was only in the 1970s that these beliefs were renegotiated, replaced by an image of bright, friendly, ocean-dwelling teddy bears. Norwegians are aware of these new conceptions, but they find nothing in them to change their traditional ideas. In fact they wonder why Americans obsess about ocean mammals rather than tackle real issues, such as the link between Third World poverty and environmental decay.

In their attempt to justify the resumption of whaling, Norwegians cite studies suggesting that the minke population has rebounded and that killing several thousand of these whales over a period of years would not endanger the species. But as Greenpeace and other antiwhaling groups have argued, the data on which these findings are based are highly suspect. While scientific advisers to the Norwegian government estimate that there are 87,000 minke whales offshore, independent experts count only half that many.

Defenders of the Norwegian position insist that the whaling industry has changed. Scientifically informed judgment and responsible management, they say, make whaling compatible with "sustainable development," an idea Norwegian Prime Minister Gro Harlem Brundtland championed at the 1992 Earth Summit. More than once, Brundtland has flown to Washington to urge sympathy for her country's position.

Alas, recent events undermine Norway's claim that the new whaling is inspired by strict moral limits. Last fall, several tons of whale meat—in boxes labeled "shrimp" and evidently headed for markets in Japan—were intercepted by customs agents at the Oslo airport. This illegal operation (Norway forbids export of whale products) was allegedly orchestrated not by a band of outlaw poachers but by a man closely linked to the Norwegian whaling association. What we are seeing thus seems less a new regime of science and sustainability than a continuation of the indiscriminate ocean plunder that long typified the history of whaling.

It took decades of study and debate about whaling—during which time many species were driven to the brink of extinction—for the international community to prohibit this ghastly practice altogether. The best possibility for drawing Norway back into the fold may be to point out that agreements like the whaling moratorium are now crucial in many other areas of environmental and economic policy. If other nations follow Norway's example and opt out of these agreements whenever national preferences are at stake, it will be impossible to forge the kinds of international commitments needed to foster sustainable development. Is a little whale meat for dinner worth that risk?■

LANGDON WINNER, author of The Whale and the Reactor, *teaches science and technology studies at Rensselaer Polytechnic Institute. He can be reached at winner@rpi.edu.*

PHOTO: L. BARRY HETHERINGTON

Reviews

BOOKS

REINING IN THE ARMS BAZAAR

The Defense Trade: Demand, Supply, and Control
edited by Trevor Taylor and Ryukichi Imai
Royal Institute of International Affairs, $15.95

BY JONATHAN B. TUCKER

ONE of the ironies of the post–Cold War world is that at the same time the United States and its European allies are seeking to halt the spread of weapons of mass destruction, they are tolerating and even promoting another form of arms proliferation: the trade in advanced "conventional" weapons such as tanks, howitzers, fighters, and frigates. Although the global arms market has shrunk in the aftermath of the Cold War, the United States has increased its market share dramatically to become the world's leading arms merchant. According to the Congressional Research Service, in calendar year 1993 arms-transfer agreements between the United States and the rest of the world totaled $22.3 billion, or 70 percent of all weapons sales.

Since conventional arms do not evoke the apocalyptic fears that nuclear, chemical, or biological weapons do, the public tends to view trade in them with complacency. Yet while nuclear weapons have not been used since 1945, conventional arms over the same period have killed and wounded millions. Transfers of conventional weapons are particularly problematic when they disrupt regional balances of power or prolong and intensify conflict. Cases in point include the Iran-Iraq War, Afghanistan, and the civil conflicts in Angola and Somalia. Arms purchases by developing countries also consume vast sums that are urgently needed for economic and social development.

The Defense Trade: Demand, Supply, and Control, a recent collection of essays by European and Japanese defense analysts, takes a thoughtful look at the factors that drive weapons proliferation and offers policy prescriptions. Although the book covers the spread of weapons of mass destruction, the essays on conventional arms transfers are more original and thought-provoking.

Keeping Production Lines Warm

In a noteworthy essay that provides an overview of the problem, Trevor Taylor, an associate fellow at the Royal Institute of International Affairs in London, examines the factors that drive arms sales. With respect to foreign-policy motivations, he contends that using arms exports to influence the behavior of recipient countries has always been of limited effectiveness. Arming a "friendly" state can backfire should it turn hostile in the future; the case of massive U.S. arms transfers to the Shah's Iran comes to mind. With the end of the Cold War, the potential foreign-policy gains from weapons sales have diminished further. Now that East and West are no longer locked in global competition, they are less concerned about winning or losing client states in peripheral areas.

One result, writes Taylor, is that economic factors have overtaken geopolitical interests as the chief drivers of arms transfers. Specific incentives include maintaining employment, obtaining foreign exchange, and extending production lines to achieve economies of scale. In addition to these state-level economic pressures for arms sales, most defense contractors today are private companies that must sell products to generate profits and keep their workers employed. According to Taylor, states have found that commercial enterprises perform better than government-run arsenals in producing defense equipment because they are exposed to international competition. The downside of privatizing arms production, however, is that companies often seek to export arms to ensure their financial health even when such sales are not in the nation's broader security interests. Private firms also prefer to design weapon systems optimized for export potential rather than tailored to meet the needs of the national armed forces.

Another important factor driving arms exports is the desire to sustain a broad-based defense industry, which is perceived as providing greater national security and self-reliance. Since the procurement cycle for equipment such as tanks and combat aircraft can be as long as 30 years, keeping design teams busy and production lines "warm" with domestic orders alone is difficult. The end of the Cold War has exacerbated the problem by greatly reducing domestic arms procurement and thereby creating large excess capacity in many sectors of the defense industry.

Taylor contends that as long as the economic and industrial incentives for exports persist, international agreement to control the arms trade will remain elusive. Indeed his analysis suggests that the defense-industrial tail has started to wag the policy dog, potentially leading to ill-considered arms sales that could increase regional tensions and damage U.S. national security.

In another essay included in *The Defense Trade,* Takeshi Ito, an official with the Japanese Ministry of Interna-

ILLUSTRATIONS: JON McINTOSH

tional Trade and Industry (MITI), points to Japan as proof that a technically sophisticated defense industry can survive without relying on arms sales. In 1967 the Japanese government banned the export of all weapons, weapon components, and equipment and technology for arms production, with the sole exception of bilateral technology transfers between Japan and the United States under the Mutual Defense Assistance Agreement. Ito claims that the Japanese defense industry has successfully adapted to this policy by diversifying into civilian production.

Regrettably, however, he provides few details. In particular, it would be interesting to know how much Japanese defense technology derives from civilian sources, the extent to which the defense industry produces components rather than entire weapon systems, and whether the government subsidizes development of specialized defense technologies that cannot be funded through domestic procurement alone. While the example of Japan offers hope, Ito's essay does not suggest a plan for other countries to implement. Like the other authors featured in *The Defense Trade,* he fails to offer a comprehensive strategy for reining in the conventional arms trade.

Defense-Industrial Restructuring

Fortunately, others have made progress on that front. In 1992 the congressional Office of Technology Assessment (OTA) performed a study in which this reviewer was a participant. We evaluated a scheme for reducing unneeded capacity in the U.S. defense industry while preserving key design and manufacturing capabilities that, once lost, would be extremely difficult and costly to reconstitute. As a first element of the proposed strategy, the United States would press ahead with research and development of new defense technologies, but the country would not necessarily build them. Prototypes of both upgraded and new technologies would be produced in limited quantities for operational field testing.

Second, the defense industry would make use of recent trends in production technology, such as concurrent engineering, in which manufacturability issues are considered during the design process, and flexible manufacturing systems, in which computerized robots and machine tools are programmed to turn out a variety of products. These approaches offer the potential for efficient, low-rate production of defense systems. For example, a plant that manufactures subsystems for tanks might also make parts for aircraft or naval vessels, as well as civilian products. Periodic upgrading of major systems and low-rate production of selected new items—along with production of spare parts and the retrofit, upgrade, overhaul, and maintenance of deployed military systems—would help preserve critical defense manufacturing capabilities.

Third, the government would adopt a policy known as "civil-military integration," in which the legal, regulatory, and technical barriers that currently separate defense and civilian production are lowered or eliminated. One element of this strategy is to reform the system of rigid and voluminous military specifications ("milspecs") for defense equipment ranging from canteens to computers, enabling the Department of Defense to purchase commercial products and subcomponents. Indeed, the Pentagon recently took some first steps in this direction. Another form of civil-military integration would be to combine the manufacture of light armored vehicles and civilian trucks on the same flexible production line, thus achieving economies of scale and maintaining employment. Such a comprehensive approach would make it possible to preserve critical elements of the U.S. defense-industrial base without increased reliance on arms exports.

The Defense Trade is to be commended for painting a clear picture of the new economic forces driving global arms exports, and for holding out the example of Japan to any who would argue that those forces cannot be countered. Perhaps this awareness—together with ideas for defense-industrial restructuring such as those in the OTA report—will eventually produce a viable strategy for controlling the proliferation of conventional weapons. ■

JONATHAN B. TUCKER is an international-security analyst who is based in Washington, D.C.

BOOKS

SCIENCE ON WALL STREET

Profits of Science: The American Marriage of Business and Technology
by Robert Teitelman
Basic Books, $23

The Billion Dollar Molecule: One Company's Quest for the Perfect Drug
by Barry Werth
Simon and Schuster, $25

BY ROBERT J. CRAWFORD

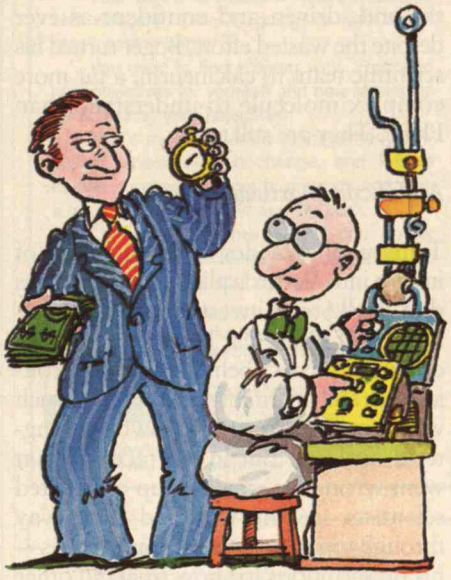
THE high-tech entrepreneur, courted by Democrats and Republicans alike, is portrayed as key to our economic future. Armed with insider knowledge of mysterious new technologies, these modern wizards purportedly sweep away conventional ways of doing business, enriching both their financial backers and the country itself. But is this image true? And on a more fundamental level, what makes such entrepreneurs tick?

Two recent books seek to answer these questions. Robert Teitelman's *Profits of Science* attempts to sketch a broad overview of high-tech entrepreneurism, while Barry Werth's *The Billion Dollar Molecule* provides a blow-by-blow description of the difficult birth of a high-tech start-up.

Teitelman, a senior editor at *Institutional Investor,* argues that the source of R&D funding has a decisive impact on emerging industries, and to prove his point he recounts the growth of several, including microelectronics and biotechnology. In the days before venture capital, he says, large corporate- or government-funded projects with deep pockets and long-term horizons developed most new technologies. Du Pont, for example, systematically harvested basic research from outside sources like MIT to produce synthetic fibers such as Rayon and nylon. The federal government developed radar, a mix of electronic technologies that catapulted Raytheon and other U.S. contractors into world dominance of the field. Smaller companies and entrepreneurs, dependent on conservative bankers or forced to rely exclusively on retained earnings, were rarely major players.

But by 1960, according to Teitelman, an elite group of firms, led by Karl Compton of American Research and Development and Jock Whitney and Benno Schmidt, Sr., of J.H. Whitney & Co., began to invest in technology-based start-ups. These companies carefully chose, then stuck by, promising entrepreneurs, and soon began to boast some phenomenal successes, among them Digital Equipment Corp. (DEC). Always a herd animal, Wall Street took notice just as traditional Blue Chip stocks were becoming too expensive for small investors. The eventual result was a flood of high-tech stock issues that sought to exploit the opportunities embodied in science- and technology-based firms. Large-scale venture capital was born, and it went on to finance a new generation of microelectronic gadgets, computers, and software.

In this new, more competitive Wall Street, the individual attention and paternalism of traditional firms were gradually replaced by cold calculations of profit, Teitelman says. Granted, the businesses of the pre-1960 era were also interested in making money, but they were willing to wait a good long time to do it, even as they invested millions. Not so the late-twentieth-century venture capitalists.



Once the computer market "matured"—and profits declined while capital-investment requirements continued to escalate exponentially—they cast around for the next "growth industry."

Atom-by-Atom Drug Design

Venture capitalists' crude formula for success—find an egghead entrepreneur with a brilliant idea who would assemble a team of managers, technicians, and hungry young scientists to create a "revolution"—applied handsomely to biotechnology. The purposeful manipulation of genetic material, investors reasoned, would allow the new industry to surpass the pharmaceutical giants, whose cumbersome methods took an average of 12 years and $230 million to bring drugs to market.

It is one of these bioventures that Barry Werth, a freelance magazine writer, singles out for a close look in *The Billion Dollar Molecule.* In exchange for allowing the company, Vertex, to check his work for factual accuracy and proprietary disclosures, Werth was admitted into the inner circle of its executives and chief scientists for four years. With masterful descriptions of both science and business deals, Werth does for the indus-

try of "rational" drug design what Tracy Kidder did for the computer industry in *The Soul of a New Machine.*

Vertex's founding visionary, chemist Joshua Boger, formerly a researcher at Merck, reasoned that instead of laboriously screening soil, insect secretions, and plant samples for drug agents as the pharmaceutical giants did, he could design drugs atom by atom to bind to—and thus inactivate—molecules instrumental in the disease process. What's more, these instant drugs would be virtually without side effects: because of the design's precision, they would adhere to their target molecules alone, so that beneficial enzymes and other chemical messengers could go about their business unimpeded. In theory, Boger's team could treat a vast range of diseases, from AIDS to the common cold.

Boger's first target molecule was FKBP, which he believed was a crucial agent of the immune system. By blocking it, he hoped to prevent the human body from rejecting transplanted organs. While Boger was out raising money—he eventually obtained $60 million, half from a Japanese pharmaceutical firm and half on Wall Street—Vertex's researchers hunkered down to isolate and analyze FKBP, whose molecular mechanics remained poorly understood. Unfortunately, the outcome of their efforts shows how the "American marriage of business and technology," as Teitelman calls it, can flounder. After over two years of pushing themselves to the brink of nervous collapse, the scientists realized that FKBP was the wrong molecule. Perhaps worse, Vertex's arch rival Stuart Schreiber—a Harvard scientist whom Boger had kicked off Vertex's scientific advisory board—discovered the immune-system agent that Vertex should have been studying: a common though mysterious cell enzyme called calcineurin.

Schreiber, Werth maintains, was able to beat Vertex because he remained outside the venture-capital game and could therefore concentrate totally on science. He did not need to sell his ideas to skeptical investors, and he did not need to hide proprietary research results but could collaborate openly with other scientists. In the end, driven and confident as ever despite the wasted effort, Boger turned his scientific team to calcineurin, a far more complex molecule to understand than FKBP. They are still trying.

A Difficult Marriage

Teitelman provides a small shred of insight into Vertex's plight when he notes that Wall Street investors didn't understand that molecular biology, unlike the quantum physics behind microelectronics, was still an infant science and as such was more suited to R&D with a long-term outlook. But in the face of what went wrong—a small group of isolated scientists seeking to wend their way through too many scientific unknowns—his prescriptions for how to avoid other fiascos are disappointing and vague. "More than anything else," he writes, "companies ... crave stability, not only in terms of the macroeconomy...but in terms of regulation and, particularly, tax policy." Teitelman then calls for an "ecology of technology" that he never defines.

Perhaps the shallowness of Teitelman's conclusions reflects his odd choice of sources and material. Instead of mining the rich academic literature on technology policy and innovation—for example, the writing of Harvey Brooks or Michael Porter, both of Harvard—Teitelman prefers to dissect the work of George Gilder, the supply-side ideologue, and John Kenneth Galbraith, with his outmoded liberal notions. Creating a crude, inaccurate dichotomy, Teitelman contrasts Gilder's fantasy that entrepreneurs will make or break the economy with Galbraith's insistence that entrepreneurs are no match for large firms when it comes to technological innovation. He acts as if these two caricatures express the essence of all relevant argument.

Moreover, it is doubtful whether the microelectronics and biotechnology industries tell the whole story of the American marriage of business and technology. Had Teitelman chosen to focus on the aeronautics industry, for example, he might have reached different conclusions—in that case, it was the promise of military markets, not commercial markets, that spurred private groups to heavily invest in new technologies.

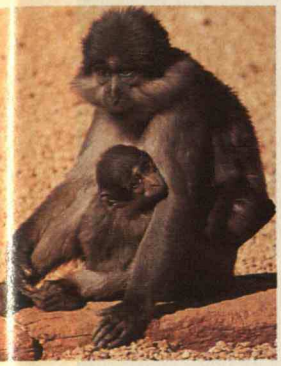
Finally, Teitelman fails to examine many important questions. Should U.S. firms attempt to "reverse engineer" innovative foreign products, allowing others to finance the costly and uncertain basic research, as the Japanese have so expertly done? Could the government step in to promote or sustain promising technologies that cannot attract venture capital? Also, Teitelman never mentions significant new developments that could help make the marriage of business and technology more successful—among them Cooperative Research and Development Agreements (CRADAs), which allow scientists from government laboratories to work with private industry and have generated around $13 billion in products. Instead, he accuses the federal government of some ill-defined "bureaucratic stifling of innovation."

Although Teitelman offers some interesting perspective into the impact and demands of Wall Street fund-raising, his work is largely unoriginal, padded with superfluous historical details to hide sparse and poorly developed ideas. It is a disappointing performance by the author of *Gene Dreams,* Teitelman's highly praised first book on the biotechnology industry.

On the other hand, Vertex's story—that of an epic failure—is fascinating and compelling. Though one wonders if Boger's unflagging self-confidence reflects a less-than-healthy narcissism—can he force nature itself to cooperate with his vision?—one cannot but wish this quintessential egghead entrepreneur the best of luck. After all, he is struggling to maintain the viability and independence of his company against odds that, thanks to Werth's skill in both researching and telling the tale, we know to be almost overwhelming. ■

ROBERT J. CRAWFORD, a former subcommittee manager in the Office of Recombinant DNA Activities at the National Institutes of Health, is now assistant director of the Office for Sponsored Research at Harvard University.

cies contemplating research on primates: no research of long-lived primates should be undertaken without funding for the long-term housing and care of any surviving individuals; and no large-scale biomedical research should be undertaken on any endangered primates. The logistical and ethical problems are just too dauting.



The scientific community also has an obligation to seek alternatives to the use of primates in biomedical research, so that one day no primates—captive-bred or wild-caught—will be subjected to painful experiments.

MARTIN L. STEPHENS
The Humane Society of the United States
Washington, D.C.

WHO'S ON FIRST

Like Dan Quayle when he helped the kid lose the spelling bee by adding an "e" to potato, you should be ashamed of yourselves for the grammatical outrage in the headline "Who's Threatening Who?" on page 72 of the July issue. Threaten is a transitive verb—that is, it takes an object—and the objective case of who is *whom*.

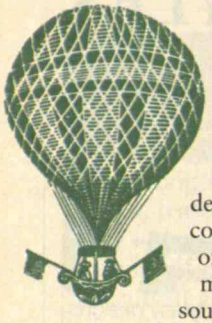
WILLIAM HINES
Lovettsville, Va.

Editor's response:
According to Merriam-Webster's *Collegiate Dictionary, whom* is "now often considered stilted, especially [when used as] an interrogative." The same source does admit that "observers have been predicting the demise of *whom* from about 1870," but given that Merriam-Webster is not the first grammatical authority to describe the use of the word as optional, we tend to avoid it when it seems pretentious, as it did in this case.

Classifieds

Phenomena

By David Brittan



Controlling Inflation When Murray Kornhauser talks about airbags, the familiar devices that bring comfort to millions of safety-conscious motorists begin to sound vaguely sinister. Many models use a sodium azide propellant—basically rocket fuel, Kornhauser points out—that can spit lye into the passenger compartment if not fully combusted. While other models substitute compressed gas for rocket propellant, all airbag inflation systems share a serious drawback: the rapid expansion of gas during a collision raises air pressure within the vehicle to uncomfortable levels. This, says Kornhauser, is why automakers do not provide airbags for the rear compartment as well as the front. With four devices popping out at once, "you would burst some eardrums," he says. A few minutes of listening to Kornhauser is enough to make you wonder why there isn't a safer way to inflate an airbag. Conveniently, Kornhauser is right on it. 3C Systems, the Wynnewood, Pa., defense firm of which he is president, has devised an inflation system that simply moves air already present in the vehicle. The air is kept in a four-inch-thick bladder built into the seat back or roof. In an accident, an "ultracapacitor"—a device that can store a powerful electric charge and release it in a jolt of current—quickly energizes an electromagnetic coil. The current in the coil sends a metal plate flying against the air-filled bladder at a speed of 100 feet per second, inflating a folded bag attached to the bladder. "If you think of those little rubber dolls where you squeeze them and the ears pop out, it's the same principle," says Kornhauser. 3C Systems uses similar electromagnetic propulsion technology for shock-testing weapons components. Although Kornhauser's contraption takes up as much space as the airbag it inflates—albeit in more convenient dimensions—he says the Department of Transportation "likes it very much," and EM Systems, a new company he has set up to develop the product, is talking with car-seat makers about building the system into their seats. Before plunging ahead with technology based on electromagnetic propulsion, however, Kornhauser has a confession to make: "I've actually been able to get this to work with a purely mechanical system, like a giant rat trap." So the airbag of the future may be powered by . . . metal springs. It's not that Kornhauser lacks faith in the electromagnetic approach; it's just that the ultracapacitors it relies on are very new: "You don't have a warm feeling that you're working with something that's been around a long time," he says.

How High the Moon? Erik Kvale, a research geologist with the Indiana Geological Survey at Indiana University, knows that warm feeling well. The specimens he works with—siltstones and sandstones of Indiana and the Southwest—date back several hundred million years. Unlike most geologists, Kvale is less interested in what rocks can tell us about the earth than what they reveal about our celestial companion. The moon is known to be gradually receding from us, but at a rate that has changed over the eons. Nobody knows how close the moon was in the distant geologic past. Kvale and his colleagues—an interdisciplinary team of researchers from Kansas State University, the Universities of Arizona and Utah, and his own institution—believe the answer is preserved in the layers of sediment that settled in estuaries to form the class of rocks known as tidal rhythmites. Each layer of such rock represents a single tide; the thicker the layer, the stronger the tide. Since the highest tides occur when the moon is aligned with the earth and the sun, says Kvale, tidal rhythmites contain a detailed chronicle of the moon's relationship to the earth. By noting the frequency of the extra-thick layers that signal such an alignment, the researchers hope to determine the speed—and hence the altitude—of the moon's orbit in different geologic periods. A preliminary finding, based on core samples from Utah, is that the moon's average distance 900 million years ago was about 224,000 miles. Since then, the moon has crept out to about 238,000 miles. If you don't feel better knowing this, bear in mind that the research falls under the heading of pure science. "We're not going to find new oil and gas deposits by determining the lunar retreat rate," says Kvale. But Charles Sonett, the University of Arizona planetary scientist who initiated the project, is quick to point out that the further back in time the moon's orbit can be established, the closer scientists will come to answering basic questions about the satellite's origin: Was it formed out of the earth? Or was it captured? And if so, how?

The Crayfish Cure While Murray Kornhauser refines his automotive bladders, a zoologist at the University of California at Santa Barbara has focused his concern on the human variety. Throughout much of the Third World, a parasitic worm known as the schistosome burrows through people's skin and damages their bladders and other major organs. Armand Kuris, along with biologists Eric S. Loker and Bruce Hofkin of the University of New Mexico, spent July in Kenya, where they initiated an experiment designed to bring this often deadly scourge under control. The unlikely protagonist in their experiment is the Louisiana crayfish, which has been raised for export in Kenya for some 25 years. The antagonist is the freshwater snail in which schistosome larvae hatch. The force the researchers hope to harness is the crayfish's appetite for snails, which approximates the gusto with which American bayou dwellers dine on crayfish. In July, Kuris and colleagues seeded Kenyan ponds and other water systems with the diminutive crustaceans. In January—by which time the crayfish population should have gained a foothold—the scientists will return and provide several hundred infected schoolchildren with deworming medicine so as to begin the study with a clean slate. The children and the ponds will then be monitored periodically for two years to see whether the crayfish are indeed keeping infections at bay. If the experiment succeeds, says Kuris, this technique could be used to control schistosome infections in other parts of the world, where a total of 300 million people are believed to be afflicted.

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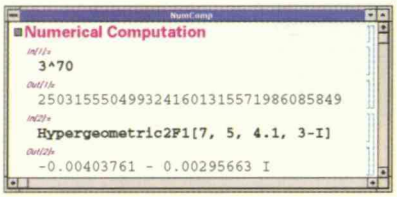

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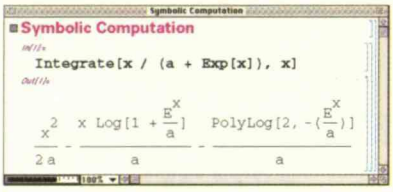

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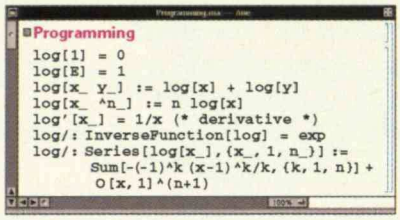

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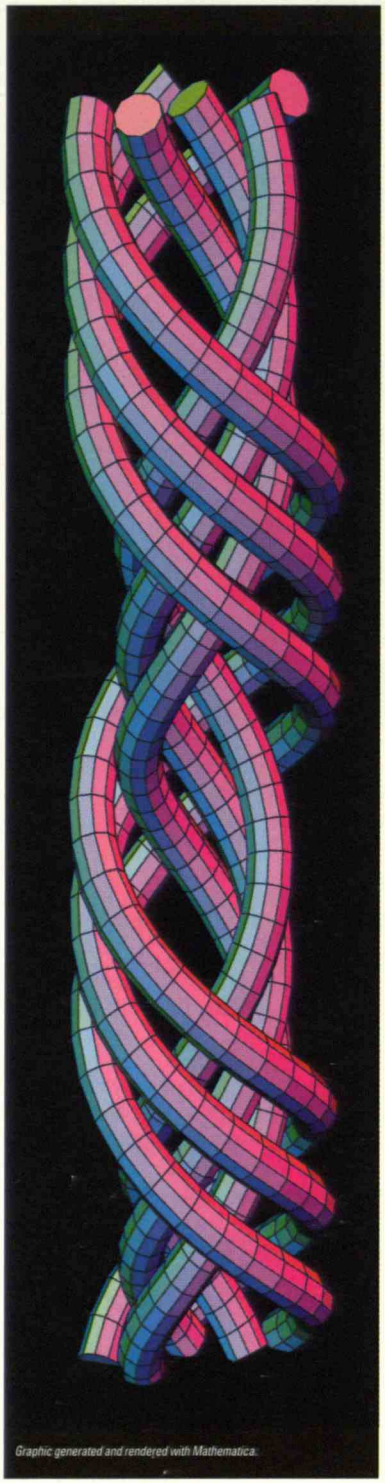

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